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THE SALAMANDERS OF THE FAMILY PLETHODONTIDAE

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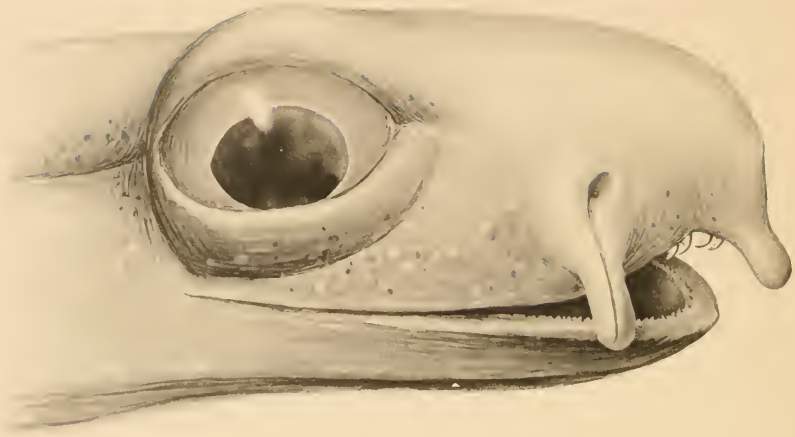

Eugene Fischer del.

Head of male Eurycea quadridigitata quadridigitata.

Raleigh, N. C.

THE SWOLLEN SNOUT, CIRRI, AND ENLARGED PREMAXILLARY TEETH ARE SECONDARY SEXUAL CHARACTERS.

THE SALAMANDERS

OF THE

FAMILY PLETHODONTIDAE

BY

EMMETT REID DUNN, Ph.D. [HARV.]

OF THE

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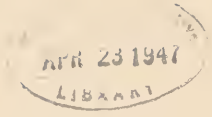
T. Barlow

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I GIVE THIS BOOK TO

THOMAS BARBOUR

FOR THE HELP HE HAS GIVEN ME

FOREWORD

Much water has flowed under many bridges since the January of the year of our Lord one thousand nine hundred and thirteen, when a college Sophomore opened a letter and read a sentence, the results whereof are the following pages. It has been thirteen years since the eighteen-year-old boy read those few words and in those thirteen years for him the surf has whitened the shores of Caribbean islands; the slopes of the Balsams have been blue in the distance; hawks have soared a thousand feet below the naked peak of Sharp Rock; the iridescent wings of Morpho have fluttered through glades in the rain forest and in the mist of the cataract at Xico; from the mooring at Vera Cruz tall Orizaba has stood against the western sky; the low sun has shone on the ice of Ixtaccihuatl, most unforgettable of mountains; step after step, for him, far out at sea, Chirripo Grande, "nie von Menschenfuss betreten," has climbed aloft; and from shaken Irazu, while the ash cloud of the eruption rose above his head and floated, a black pall beaten by the fierce wind, he has seen through a break in the clouds, far to the Southwards, the sheer and menacing shaft of rock which is Cerro de la Muerte.

And in that letter and in that sentence there was no hint of high peaks or of distant places, of mountains seen and unclimbed and forever remembered, of the coughing of tigers by night in the black forest, there were only these words in that letter from Leonhard Stejneger "I would like to point out to you, however, that Herpetology offers fields more in need of investigation than the snakes, viz., the salamanders."

Bald and prosaic words these, true though they were. Bald and prosaic has much of the work been, and, for those who venture further in what lies hereinafter, there is aridity and to spare. This is deplorable enough, but unavoidable, and while the written accounts of genera and of species unquestionably make dull reading, and were, it must be confessed, dull writing, yet the taking of specimens and the gathering of data and all that went therewith, and the remembrance thereof, has more than outweighed the dullness.

And it must have been so with the many others whose work has here been synthesized. It cannot have been all drudgery, the work of

the men who have accumulated the specimens and the information in the 125 years since first Palisot de Beauvois collected around Philadelphia, and since Sonnini described the *Salamandra rubra* which he brought back. For every specimen of the 12,000 and odd about which this book has been written was taken in the field by collectors who found them on their own land and close to their own homes, and discovered strange creatures in familiar places, or by collectors who half a world away from their own country met places and animals and men that they had not seen. They were dull, and not the work, if there was not for them some thrill therein.

One hundred and fifty-three times some one of these creatures has been described as new, and, whether in field or in museum, in the recognition of a novelty as it was first divulged to intelligent and appreciative eyes, there has come a peculiar and high satisfaction. Highest of course when the collector realizes that he has caught and holds in his hands an unknown animal, only less high when home from the hunt he finds a new beast among his spoils, and high enough when, envisaging the spoils of another, he sees among them one strange to him and to science.

Nor is a novelty necessary. Many an one has dreamed of some rare creature, and has traveled far, and known much discomfort in search thereof, and the final meeting is overpayment. Conrad, in the twentieth chapter of *Lord Jim,* has depicted the appropriate emotions, and Stein felt there what many another has felt elsewhere.

It is not in the collecting of specimens, in the observing of habits, in the examination of museum material, or in the search through the literature that one encounters ennui. Rather it is after all the material is at hand, and all the information is gathered that the unalloyed drudgery begins.

Now that drudgery is over, and I can remember how puzzling the first few specimens of the commonest species were to me, and how I foolishly imagined that the first grown males of *Desmognathus fuscus* that I caught and examined were the desiderate *Leurognathus,* because they too lacked teeth on the prevomers.

And I can remember the first gigantic specimen of *quadra-maculatus* that I took at Brevard; and how I saw for the first time *gutto-lineata* in the light of an electric torch, and it was climbing on a bush, and how it leapt violently down into a deep ditch and was lost to me, and how

many days went by before I ever saw another. And I remember *Plethodon metcalfi* at See-Off, when half the ridges of the Southern Appalachians rode in dark blue waves across the French Broad valley, and how few of them there were on that bare and wind swept crest. And how, on the slopes of the Grandfather, some chance-turned log disclosed the red band on the back of *yonahlossee*, and I knew that an unknown species was before me.

I can remember climbing White Rock on a special trip for *jordani* which I had never seen; I climbed a thousand feet before I saw the first, but I had thirty-seven when I came down.

At Navarro there was the big, gray, *robustus* that lived in the fallen tree in the forest, and, in a pasture near Jalapa, among stones at the foot of a tree, the pair of black-and-golden *bellii*.

Or I remember how the snake I saw at La Loma, when I turned the leaf and it slid into the water, changed into *collaris* when I caught it; or how I came by night upon the type of *Oedipus colonneus*.

Yet it is the places that stick in my mind, which I had not seen but for *Desmognathus* or for *Oedipus*.

Cedar Rock in the rain, when the face of it was a waterfall a thousand feet high and a half mile wide, water pouring out from the spruce forest on top, and spreading out over the great dome and down with a mighty roaring to its hidden base.

The cliffs of Lost Cove and the Escarpment of the Blue Ridge down which we went all one long day, with our senses of direction clean gone, and dark came on, and we followed trails in the woods which ended blindly, until across three ridges we heard a cow bell and the bark of a dog.

The silence of the spruce forest on White Top, and the thick moss on the ground there.

The rocky pool on White Rock, with the Tennessee valley three thousand feet below, the Cumberland Front a dim line to the west, Guyot and Clingman's Dome looming up through the mist that hung along the line of the Smokies, when all there was between me and the Richland Balsams was miles of air and a hawk soaring.

Coming into port at Limon, with the pelicans and frigate birds rattling by on their coarse wings, and a look to them as if they had been drawn by Doré.

The oak forest on Irazu, when our horse hooves made no sound in

the soft ash, and the leaves of the oaks were gray from the ash, and it was very silent as we rode: until about dusk the wind swooped from behind the shoulder of the volcano, very cold with a cold rain, and we stopped to put on our ponchos, looking back and far below, where the lights were coming on in Cartago and Paraiso, cities of the plain.

Riding by night from Alajuela to San Pedro de Poas over bridges across torrents which roared and were white in the moonlight.

On top of a train with Mexican soldiers riding from Xico to Jalapa, when Cofre de Perote towered above us like some misshapen lion, and the white cone of Orizaba rose above hill after hill as the train went by.

And events not wholly connected with salamanders come into my mind and need no effort of recollection.

The heave of the earth and the glimpse of the under fires in the afore-mentioned eruption of Irazu; the fer-de-lance at the ford of the Bananito, when I picked up the bridle of a mule and a six-foot snake with it; the first time I heard the red howlers, alone in the woods above Navarro; night at La Loma, and something coughing, and Celso who said *"aqui viene el tigre";* the peons, drunk and fighting, on pay day at Guapiles; the sudden appearance of forty horsemen with rifles and banderillos one night at Cerro del Gallo; and the terrible weariness of the path to Tlamacas.

Places and happenings, people and animals, winds at sea and on mountains, and all that I remember, it was no unpleasant path I trod when I followed this "questing beast" or that, nor have all of them been unattainable, and with this foreword I commend the remainder to the reader, who will, I doubt not, turn elsewhere before many pages, *Bueno, vaya usted con Dios.*

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Frontispiece. Head of Male *Eurycea quadridigitata quadridigitata.*

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INTRODUCTION

This is a book about salamanders, a name not unknown to folk lore, mythology or even slang.

To folk lore because the salamander of Europe finds congenial quarters in dead logs which the peasantry from time immemorial have found equally fit for the hearth. With his roof tree blazing over him the salamander would make his exit from his home and would arrive on the hearthstone, having obviously come out of the fire, thus firmly convincing the peasant that the natural habitat of the salamander was the flame. Benvenuto Cellini tells of such an occurrence, which was impressed on his childish mind by a father who, peasant though he was, had some inklings of psychology.

Later, when the four elements were assigned their spirits by Rosicrucian mystics, the salamander naturally became the spirit of the flame, and was decidedly improved in form, features and customs, as the curious may easily discover in Anatole France's *Rotisserie de La Reine Pedauque.*

Later still, Owen Johnson, in a work of fiction anent young girls who played with fire without getting burnt, used the word *salamander* in that connection, and for a while it was current slang.

Hereinafter the salamanders are most nearly related to those of folk lore and of Europe, for folk lore is but misinterpreted and insufficient observation. Even about these forms there is folk lore, and Mexican women and Costa Rican children hold *"tlaconete"* and *"escorpion ciego"* in improper dread. In this country salamander is a word unknown save to the learned, and *"lizard"* and *"ground puppy"* are indiscriminately applied to most of the species.

The animals which I am about to discuss form a large natural group or *family,* descended from a common ancestor. This family may be subdivided into fifteen smaller natural groups or *genera.* There are in the family 86 known kinds or forms of salamanders, each kind or form being different from all the others. Some of these are completely distinct from any of the others and are *species,* while some are connected with each other by intergrades and are *subspecies.* There are 71 distinct species.

These animals inhabit the island of Sardinia; southeastern France

and the adjacent northwestern part of Italy; most of North America; northwestern South America, south as far as Bolivia, and east as far as Venezuela; and the region of the Rio de la Plata. This range is, at present, what is called a discontinuous one. It is obviously the fragmentary state of a formerly continuous range which once extended unbroken at least as far as the present extremes. The geographical center of this range (that is the geometrical center of the range, allowing for the configuration of the continents, the center from which the extremes are equidistant by overland routes) is the eastern United States.

1. Part of the World, on a North Polar Projection, showing range of the Plethodontidae.

The closest allies of the family *Plethodontidae* are found in the two European genera *Chioglossa* and *Salamandra,* which together form the family *Salamandridae.* Less closely allied are the *Amphiumidae,* the *Pleurodelidae,* and the still more remote *Ambystomidae,* and *Proteidae.* These six families make up the suborder *Salamandroidea,* characterized by the common possession of a peculiar and unique method of internal fertilization, involving the presence of a spermatheca in the female; and by the branchial apparatus, in its adult condition, being made up of two ceratobranchials and one epibranchial, all firmly connected.

A brief summary of the distinguishing characters of these families may elucidate the relationships. The significance of the characters mentioned will be discussed later.

1. *Proteidae*

These are permanent larvae, not obviously related to any one of the other families.
An anterior projection of pubis.
No ypsiloid cartilage.
Body muscles larval; no rectus abdominis muscles.
Lungs present.
Branchial arches larval, but second ceratobranchial much reduced.
Columella and operculum fused together, free from periotic.
Skull characters larval.
No neural ridge on the amphicoelous vertebrae.

2. *Ambystomidae*

No anterior projection of pubis.
An ypsiloid cartilage.
Body muscles primitive; a rectus abdominis superficialis; no rectus abdominis profundus.
Lungs present.
No naso-labial groove.
A well developed otoglossal.
Columella and operculum variable: 1. Both present, both free. 2. Columella free, operculum absent. 3. Columella fused to periotic, stylus present; operculum free.
No posterior projection of prevomers.

No trace of postfrontosquamosal arch.
A bony pterygoid.
No neural ridge on the amphicoelous vertebrae.

3. *Pleurodelidae*

No anterior projection of pubis.
An ypsiloid cartilage.
Body muscles primitive; a rectus abdominis superficialis; no rectus abdominis profundus.
Lungs present.
No naso-labial groove.
No otoglossal.
Columella fused to periotic, stylus absent; operculum free.
A posterior projection of prevomers.
Usually a well-developed postfrontosquamosal arch.
A bony pterygoid.
A neural ridge on the opisthocoelous vertebrae.

4. *Salamandridae*

No anterior projection of pubis.
An ypsiloid cartilage.
Body muscles lacking the obliquus internus; both rectus muscles developed.
Lungs present.
No naso-labial groove.
A poorly developed otoglossal.
Columella fused to periotic, stylus present; operculum free.
A posterior projection of prevomer.
No postfrontosquamosal arch.
A bony pterygoid.
No neural ridge on opisthocoelous vertebrae.

5. *Plethodontidae*

No anterior projection of pubis.
No ypsiloid cartilage.
Body muscles lacking the obliquus internus; both rectus muscles developed.
Lungs absent.

A naso-labial groove.
A poorly developed otoglossal.
Otic apparatus either: columella and operculum fused, latter attached by a narrow isthmus to periotic; or operculum free, columella? *(Batrachoseps).*
A posterior projection of prevomer is represented by patches of teeth on the parasphenoid.
No postfrontosquamosal arch.
No neural ridge on the either opisthocoelous or amphicoelous vertebrae.

6. *Amphiumidae*

No anterior projection of pubis.
No ypsiloid cartilage.
Body muscles larval; no rectus abodminis muscles.
Lungs present.
No naso-labial groove.
Branchial arches larval; but first ceratobranchial and first epibranchial fused; second ceratobranchial much reduced.
Columella and operculum fused; latter attached by narrow isthmus to periotic.
A posterior projection of prevomer.
No postfrontosquamosal arch.
A bony pterygoid.
A neural ridge on the amphicoelous vertebrae.

The actual primitive characters are found in the *Pleurodelidae* and in the *Ambystomidae*. Many of them are not mentioned in these lists. These two families have also the primitive habits. There are varying degrees of lung and ypsiloid reduction in the *Ambystomidae, Pleurodelidae,* and *Salamandridae*. The *Proteidae,* as permanent larvae, can be compared only with larvae of the transforming families. Among these they seem least similar to the *Plethodontidae* and the *Amphiumidae*. The *Salamandridae* seem to be an offshoot of some primitive Pleurodelid. Except for the otic apparatus the *Plethodontidae* can be most easily derived from the *Salamandridae*. Their otic apparatus is an independent derivative from the most primitive (or from the larval) type in the group.

The forms herein discussed have only a very remote relationship with the two other suborders of the *Caudata;* the *Meantes,* containing

the family *Sirenidae,* and the *Cryptobranchoidea,* containing the families *Hynobiidae* and *Cryptobranchidae.* Even this remote relationship is by way of the two more primitive families of the *Salamandroidea,* the *Ambystomidae* and the *Pleurodelidae.*

The *Plethodontidae* and the *Amphiumidae* are the most specialized families of the *Salamandroidea,* and the former comprise over half the known species of the order, and are unquestionably the modern, flourishing group.

The characters that distinguish this family from the *Salamandridae* are of two sorts; those dependent on general weakening of the skeleton, as lack of pterygoids, lack of actual posterior projections of prevomers, and amphicoelous vertebrae; and those consequent to mountain brook life, as loss of lungs, naso-labial groove, loss of ypsiloid cartilage, and state of the otic apparatus.

The first set are merely the ultimate working out of tendencies inherent in the group as a whole, tendencies which develop from *Tylototriton,* with its bony temporal arcade, maxilla reaching to the quadrate, and pterygoid suturally connected to maxilla, to the fused premaxillae, missing prefrontals, missing pterygoids, and poorly ossified parietals and frontals of *Oedipus uniformis.*

The second set are seen to some degree in the species of *Onychodactylus, Rhyacotriton, Neuergus, Euproctus, Salamandrina,* and *Chioglossa,* representing four families of salamanders. All of these are mountain brook forms and all of them are independently undergoing lung reduction.

The lungs of salamanders are rather hydrostatic than respiratory, and they function in connection with the ypsiloid cartilage and muscles as a hydrostatic mechanism. (Whipple 1906, Biol. Bull. 10). This hydrostatic mechanism is obviously of advantage in still water, and of equal disadvantage in current. The primitive salamander was largely terrestrial, and repaired to ponds to breed as do the anatomically primitive members of the three most unspecialized families, the *Hynobiidae,* the *Ambystomidae,* and the *Pleurodelidae.* Those forms which live or breed in mountain brooks, where the swift current precludes leisurely swimming and makes crawling on the irregular bottom the safest mode of locomotion have tended to lose the hydrostatic mechanism of their ancestors. Loss of lungs and of ypsiloid apparatus is a rheotropic adaptation. (Wilder and Dunn, Copeia, 1920, p. 63).

The naso-labial groove (Whipple 1906, Biol. Bull. 11), is an adaptation to the bucco-pharyngeal respiration consequent upon loss of lungs. This structure is universal in the *Plethodontidae* and is not found elsewhere, and it affords the most convincing proof that the family as here considered is a natural group.

The otic apparatus of the majority of the forms in the family retains the functional columella, which is the otic mechanism of the aquatic larva of the entire group. (Reed 1920, Journ. Morph. 33, p. 325). This is evidently another adaptation to mountain brook life in which the adult, as well as the larva, is largely aquatic.

The family is then a group derived from primitive Salamandrids, more degenerate than they in degree of ossification; specialized beyond them in adaptation to mountain brook life; and retaining a modified larval otic apparatus as another adaptation to the same habitat.

DISPERSAL

We may now consider the spatial and chronological origins of the group.

There are various methods in vogue for use in determining the place of origin of a group of related animals or plants. C. C. Adams (1902, Biol. Bull. 3, p. 115) gives ten criteria for use in this determination. Most of these seem based on *a priori* conceptions and many of them are highly unsatisfactory, but they merit consideration as being the most elaborate set of rules yet proposed. Some of them have such similar ideas as their bases that they can best be considered as sets.

2. Location of dominance or great abundance of individuals.
4. Location of maximum size of individuals.
5. Location of greatest productiveness and its relative stability.

These three are all expressions of the idea that the *place* of *origin* is the *present region* of *optimum conditions*. This is, of course, absurd. It is perfectly obvious that the animals may be entirely extinct at the place of origin. These criteria may or may not have been true for any group in the past, they are certainly not necessarily true for any group in the present.

1. Location of greatest differentiation of a type.
3. Location of synthetic or closely related forms.
7. Location of least dependence upon a restricted habitat.

These three may be true of the center of origin. They might

equally well be true of any place in the group range which possessed an equally varied assortment of ecologic niches, and would be more true of any place in the range which possessed a more varied assortment of ecologic niches. These three carry an idea of a generalized animal and a generalized environment.

The first three of these criteria might hold true at both the time and place of origin; the second three would hold true at the same time and place; the trouble with the whole six is that none of them would necessarily hold true for the place of origin after the time of origin.

6. Continuity and convergence of lines of dispersal.

8. Continuity and directness of individual variations or modifications radiating from the center of origin along the highways of dispersal.

9. Direction indicated by biogeographical affinities.

These three should hold true of the place of origin at any time. The difficulty of determining that place still remains.

Adam's tenth criterion, the "Direction indicated by the annual migration routes in birds," is of course inapplicable in this case even if true.

Other criteria have been used from time to time. The region where primitive forms now occur has been so often held to be the place of origin of a group that I am unaware who first promulgated the idea.

The exact opposite has been maintained recently by Matthew (1915, Ann. New York Acad. Sci. 24, p. 171), who elaborates a whole theory of dispersal. His theses follow:

1. Secular climatic change has been an important factor in the evolution of land vertebrates and the principal known cause of their present distribution.

2. The principal lines of migration in later geological epochs have been radial from Holarctic centers of dispersal.

3. The geographic changes required to explain the present distribution of land vertebrates are not extensive and for the most part do not affect the permanence of the oceans as defined by the continental shelf.

4. The theories of alternations of moist and uniform with arid and zonal climates, as elaborated by Chamberlin, are in exact accord with the course of evolution of land vertebrates, when interpreted with due allowance for the probable gaps in the record.

5. The numerous hypothetical land bridges in temperate, tropical and southern regions, connecting continents now separated by deep oceans, which have been advocated by various authors, are improbable and unnecessary to explain geographic distribution. On the contrary, the known facts point distinctly to a general permanency of continental outlines during the later epochs of geologic time, provided that due allowance be made for the known or probable gaps in our knowledge.

6. Whatever agencies may be assigned as the cause of evolution of a race, it should be at first more progressive at its point of original dispersal, and it will continue this progress at that point in response to whatever stimulus caused it and spread out in successive waves of migration, each wave a stage higher than the previous one. At any one time, therefore, the most advanced stages should be nearest the center of dispersal, the most conservative stages farthest from it.

With most of the above I heartily agree. It in general expresses nothing inconsonant with what I believe to have been the history of the *Plethodontidae,* but the last thesis gives, I think, only half the truth.

It is obvious that an animal may be subjected to environmental change in one of two ways: either he may migrate to a new environment or he may stay where he is and the environment may change over his head. Now it is ever becoming more evident that evolution as an actual series of anatomical changes is largely the expression in animal form of the environmental changes to which the ancestors have been subjected. This holds true as well for the extreme followers of Weismann as it does for the extreme followers of Lamarck, because the indirect effect of the environment (Natural Selection) seems to the former as potent as the direct effect of the environment does to the latter. It is also fairly evident that little evolution goes on in the absence of environmental change, although this environmental change may be so slight as only to separate two sets of the same species and thus to prevent mutations arising in one set from passing to the other set with the result that the two become different.

Now the two ways in which animals, adapted, as all must be or perish, to a given environment, are subjected to the harsh influences of a new environment, to which they are not adapted, are due to quite different causes and produce quite different results.

These two ways are due to Overcrowding and to Environmental Change. Matthew has considered only the latter, and with his remarks about the effects of the latter I quite agree.

Overcrowding is a constant phenomenon in animal groups. Its significance was clearly seen by Darwin and I need allude here only to its bearing on dispersal. Under the pressure of Overcrowding most if not all animal species are continually trying to extend their ranges and to live beyond the bounds of the environment to which they are adapted. Probably most of the individuals who make this attempt perish. Probably few of the species are successful. But the situation for nearly all species is one in which there is no incentive or necessity for those at the center to change, but a constant incentive and a constant necessity for those at the periphery to change. This situation, sufficiently prolonged among forms of any plasticity, is bound to result in a central form which has not changed and peripheral forms which have changed. In other words a type of dispersal in which the primitive types are left at the center and the specialized are at the periphery.

In the case of Environmental Change it is the home range, the region of adaptation, which is disturbed, and it is the animals there which are under the necessity of either readapting themselves to the new conditions or of migrating to some new region where the old conditions are still extant, and as environmental change ordinarily comes gradually and by progressive encroachment this is usually feasible, and there is sufficient opportunity for the non-adaptive individuals or species to follow the receding belt of old conditions.

It is the continual recurrence of such events which has brought about the state of affairs described by Matthew, in which the more specialized types are at the point of origin of the group and the more primitive at the periphery.

Thus two entirely opposite types of distribution may result from the operation of dispersal under different pressures. The type resulting from Environmental Change is probably more often found in the case of large groups, large areas, and long periods of time; because none of these three alone, and still less all three in combination, can ever be free from the pressure of changing environment. On the other hand, small groups, in small areas, during short periods of time,

may well be free from the effects of environmental change but never free from the pressure of Overcrowding.

There is one similarity in the distributions resulting from these two types of dispersal, and that is the position of the point of origin in regard to the entire range. In both the point of origin is central, and the dispersal is radial. No matter where the primitive or the advanced forms of a group are found the center of dispersal of that group should be the *geometric center* of the group range; or better, the *geographic center,* by which is meant the center of available migration routes. This idea is not definitely stated by Matthew, but it underlies his whole conception of radial migration from Holarctic centers, for granted continental permanence, the southern continents are radial to the northern land mass.

In the case of the *Plethodontidae* this center is the eastern United States.

We have a further criterion in the case of this family. As a lungless group of salamanders they must have taken on their family characters in a mountain brook habitat, in a region of mountains.

It is also fairly evident that if any of the animals still survive in the ancestral type of habitat they should be in or near the ancestral region, since dwellers in mountain brooks are obviously not suited for migrations unless they abandon that habitat.

Plethodonts today survive in three general ways of life; the original mountain brook existence, restricted to the eastern United States; a mode somewhat more aquatic, also restricted to the eastern United States; and a mode entirely terrestrial, which is found in the eastern United States, on the Pacific Coast, in Europe, and in the Tropics. This widespread terrestrialism is secondary and its assumption was a necessary preliminary to any lengthy migration from a mountain region.

The mountain region of the eastern United States is the Appalachian uplift. Appalachia is the center of the group range, it is a mountain region, in it are found the forms now living in mountain brooks, and it seems to be unquestionably the center of origin. The most primitive forms are found here, all the groups of the family are found here and are not all found elsewhere, and some of the forms are very specialized. This differs from the distribution sequent to Matthew's type of dispersal because Appalachia is an old and a conservative

region, while the migration of primitive forms out from the center is caused by changing conditions at the center. On the contrary, in Appalachia there have been mountains since the close of the Paleozoic; a climate now the most humid in the East; formerly not less humid, since the uplifting of three mountain ranges to the west, and the filling in of the Mississippi Embayment can only have decreased the rainfall. Therefore, in this most stable of regions there has been no such cyclic swing of change as sent out incessantly higher and higher types from the northern hemisphere. Appalachia is, for the *Plethodontidae,* a region of origin and a region of survival.

The element of time is at best a very uncertain one. There are no fossils of the group and one can only surmise their antiquity by a few facts. One is that another specialized family of salamanders, the *Cryptobranchidae,* are known from the European Oligocene. Another is that these animals, so ill adapted for migration, have entered as far into South America as many a mammalian group, and hence their migrations must have taken place at the time of or before the mammalian invasion of the Southern Continent. Thirdly, the widely sundered species of the genera *Hydromantes* and *Ensatina* still retain practical identity, so that one Californian species is almost exactly like a European species, and another Californian form is almost indistinguishable from one from Uruguay. *Hydromantes* and *Ensatina* are less primitive than *Gyrinophilus* and *Plethodon.* If specific characters are as old as this conservatism seems to imply, the family characters must be vastly older.

There has been, however, a certain sequence of events in the history of this family, and each event of this sequence implies a period either of continental elevation and connection or of continental depression and separation.

This sequence of events is as follows:

1. *Salamandridae* in Europe and in North America. Connection between the two continents.

2. Separation between the two continents. The American *Salamandridae* take to the mountain brooks of Appalachia and assume the family characters of the *Plethodontidae.*

3. Connection between the two continents and to South America. The *Plethodontidae* become in large part terrestrial, and as terrestrial forms invade western North America, Europe, and South America.

4. Separation between the two continents. Extinction of forms, and fragmentation of formerly continuous ranges of many genera.

The last is obviously the present state of affairs and can be considered Pleistocene to Recent.

In order not to exaggerate the age of the group it is perhaps less erroneous to take each period of upheaval or depression working backwards from Recent.

4. Pleistocene to Recent. — Extinction of many forms.

3. Late Miocene to Pliocene. — Migration to Europe and to South America.

2. Late Eocene to Miocene. — Family characters taken on.

1. Early Eocene. — Still connected with *Salamandridae.*

This fits well with the much better known history of mammalian groups during the Tertiary. The periods of isolation and of invasion have been worked out on mammalian groups, and, although the early events in the history of the *Plethodontidae* may really have occurred in some more remote period of depression or upheaval, they cannot well have occurred in any less recent period. The family characters must have been assumed at the latest in the early Tertiary.

It might be well to consider here for a moment the application of the theory of Age and Area to these salamanders. This theory holds in general that the larger the number of forms the older the group, the larger the area of range the older the group, and vice versa. The *Plethodontidae* are certainly less primitive than the *Salamandridae,* the *Ambystomidae,* the *Pleurodelidae,* or the *Hynobiidae.* They are therefore a younger group, but they contain more species than the other four families combined. On the other hand, other specialized families, also young, contain only a very few species.

In the same way Plethodont genera show cases both for and against this conception. *Gyrinophilus* is probably the most primitive genus in the family, certainly the most primitive among the free-tongued forms. Yet it has only two species and a narrow range compared to that of *Oedipus* with its 30 species. And *Oedipus* is the most specialized of the free-tongued forms. On the other hand the highly specialized genera *Leurognathus* and *Typhlomolge* are monotypic. It seems to me obvious that genera are monotypic both at their inception and at their extinction so that there is statistically no difference between very young groups and very old ones. Mature and success-

ful genera have numerous species. But Age and Area is of no service in determining comparative age of forms of this family.

HABITS

The habitat and mode of life of *Desmognathus quadra-maculatus* and of the species of *Gyrinophilus* should give us a good idea of the character and surroundings of the ancestral Plethodont. Very active, aggressive, wanderers, they are fit descendants of ancestors who left Appalachia to form colonies as far afield as Southern Europe and Argentina and whose progeny number half the known species of salamanders.

Beginning with the mountain brook ancestors almost the entire history of the family has been involved in the abandonment of the brook habitat for a land habitat. This terrestrialism finds its expression in the whole *Plethodon* group and in the end members of the *Desmognathus* group and of the *Eurycea* group.

The reverse process has taken place in the case of certain species which have become more aquatic as *Leurognathus marmorata,* or more aquatic and cave dwelling as *Typhlomolge rathbuni,* or mud-dwelling as *Stereochilus marginatum* and to a less degree *Pseudotriton montanus.* A continuation of the terrestrialization is the semi-arboreal mode of life of the species of *Aneides* and of many of the species of *Oedipus.*

Another variant is the assumption of fossorial habits by *Batrachoseps* in the ground and by *"Oedipina"* and *Plethodon jordani* in rotten wood.

The extensive burrows made by several of our Eastern *Plethodons* are also evidences of this tendency. Yet structural modification for fossorial life is found chiefly in *"Oedipina"* and *Batrachoseps.*

Much remains to be discovered concerning the life histories of these animals. What is known concerning each species will be found under the appropriate headings yet it may be well to give a brief summary and comparison of the somewhat scanty facts.

While fertilization is unquestionably internal in all the forms, and is effected by means of spermatophores, it is not certain whether these are transferred directly from the male to the female cloaca, as certain observations on *Desmognathus fuscus fuscus* seem to indicate; or whether they are deposited by the male and taken up by the female as

has been observed in *Hydromantes italicus,* and as takes place among the *Pleurodelidae* and *Ambystomidae.* Observations on *Desmognathus fuscus fuscus* and on *Hydromantes genei* indicate that there may be an amplexus or even a complicated Liebespiel. Nothing has been observed concerning the mating habits of any other forms, and even in these few cases the observation are all incomplete.

All the known eggs laid by members of this family are provided with a large amount of yolk and have no pigment. Those laid by the brook dwelling species are much alike and probably represent the primitive type and site. They are attached singly by peduncles to the under side of stones in or near the water of brooks or springs. Usually a whole batch will be attached to a single stone. The observations indicate that the mother guards eggs laid in these situations in many if not all of the species. Such eggs, in such situations, are laid by *Desmognathus quadra-maculatus, D. phoca, Leurognathus marmorata, Gyrinophilus porphyriticus, G. danielsi, Pseudotriton ruber ruber, Eurycea bislineata bislineata, E. b. wilderae, E. b. cirrigera,* and *E. longicauda.*

Pseudotriton montanus montanus, Eurycea quadridigitata quadridigitata, Ensatina eschscholtzii, and *Hemidactylium scutatum* lay separate eggs which are very slightly if at all pedunculate. These adhere in the case of the *Pseudotriton* and the *Eurycea* to the underside of dead leaves in springs or in feeble trickles of water. The eggs of *Hemidactylium* adhere to moss above the water. The eggs of *Ensatina* adhere to each other somewhat, but are not attached to any object, and are laid on land.

The eggs of *Plethodon cinereus* are laid separately and adhere like a bunch of grapes to each other and the whole bunch is attached to some object and *P. vandykei* has similar eggs.

The eggs of *Aneides flavipunctatus* and of *A. lugubris* have long peduncles and are either separate or the peduncles adhere to each other at the point of attachment to an external object.

The eggs of *Desmognathus fuscus fuscus* (and apparently also the related races *carolinensis, ochrophaeus,* and *brimleyorum*) are rather like those of *Plethodon* but do not adhere to an external object, and the bunch tends to be elongate and occasionally somewhat like beads on a rosary.

Batrachoseps attenuatus attenuatus lays eggs which are variously described as like beads on a rosary or separate.

There is thus no great divergence in the eggs, all being fundamentally separate, and more or less pedunculate. The variation in the length of the peduncles, and in the attachment of the peduncles to each other or to an external object, suffices to account for the different appearances of the batches of eggs.

Hydromantes italicus and *Oedipus adspersus* are known to produce living young.

EVOLUTION

The groups within the family are variously related to each other. The superspecific combinations of animals have ever been more open to argument than the species themselves, for while a species is a distinct kind of animal, all superspecific groupings, involving as they do, the concept of relationship, may vary in size according to the opinions of individual workers, even if the individual workers are thoroughly in accord as to the relationships of the species.

The considerations which have guided me are both theoretical and practical. The process of speciation by isolation, which is the most important method among vertebrates, results in a series of distinct forms, all ecologically analagous, and all closely related. This is theoretically the smallest superspecific natural group and is the normal vertebrate genus. Practically, however, unless the intervening links between one such group and another have become extinct, the two are impossible to define and to separate. Thus the practical element of distinctness must be added to our theoretical qualifications of difference and relationship. As a matter of fact, it is in only a few cases that two ecologically distinct groups are connected by existing species. This is unfortunately true of the large genus *Oedipus*, which contains many extremes, and whose range of variation exceeds that of most of the other genera so that its definition is somewhat difficult. In this case the extinction of a few species would result in the establishment of at least four genera which have at present to be merged into one. I am not in favor of using subgenera because they are always elevated into full genera by later workers and because even with their use there is the necessity and the difficulty of allocating the intermediate species, the links which are, unfortunately for the logic of the

situation, not missing. In general, however, a natural superspecific group, which is definitely distinct from any other, is also on a definite ecological plane of its own, and these two concepts are at the basis of the genus as the word is used in this paper. Supergeneric groupings are not so subject to ecological definitions. Evolution and extinction have progressed further, and it is sufficiently easy to find natural groups of genera which are abundantly distinct from other such groups. Such groups of genera are families, and such a group of genera is the family *Plethodontidae*. True, two genera, *Desmognathus* and *Leurognathus*, form a natural group which is distinct from that formed by the remaining genera. Yet they are obviously descended from the same stock, and while, in strict logic, they might well be considered apart, they agree with the rest in all the essentials wherein both groups differ from the *Salamandridae*, and partake with them in the ecological distinction of the same mountain brook origin.

The species of *Desmognathus* and *Leurognathus* are more highly specialized for mountain brook life than any of the other forms of the family. They represent the ultimate workings of the original trend, and the most specialized form is, logically enough, entirely aquatic.

Fortunately, there are good criteria by means of which the primitive forms can be recognized. These are: 1. Presence of teeth on the prevomer throughout life, and 2. Absence of marked sexual dimorphism. On these two counts *quadra-maculatus* is the most primitive species of *Desmognathus*. Its breeding habits are also primitive. It seems to be restricted to streams over 2,000 feet elevation in the southern Appalachians, where it is extremely common. It shows no signs of splitting into races or of intergrading with its allies. The next most primitive form, *phoca*, has a much wider range and a different habitat. Instead of being, like *quadra-maculatus*, an animal of streams, it is a creature of the banks of smaller brooks. There is very little sexual dimorphism to be seen in *phoca* and the vomerine teeth are lost only occasionally by very old males. The coloration of an indefinite light dorsal band is like that of all the other forms of the group save *quadra-maculatus* and it may be that *quadra-maculatus* is secondary in this respect.

The breeding habits of phoca are similar to those of *quadra-maculatus* but the eggs are not always laid in the water. The ecological proclivities of *phoca* are shared by *fuscus, auriculatus* and *brim-*

leyorum. These four occupy different country, *phoca* holding the mountains, *fuscus* the north, *auriculatus* the southeast, and *brimleyorum* portions of Arkansas and Texas. Intergradation is proven between *fuscus* and *auriculatus*, probable for *brimleyorum*, and almost certainly does not occur in the case of *phoca*. The breeding habits of *fuscus* and probably of *auriculatus* and of *brimleyorum* are much more terrestrial. There is much overlapping in the case of the ranges of *fuscus* and *phoca*.

There are indications of the splitting of *fuscus* into two forms, one for New England and one for the rest of its range. But the differences, though recognizable, are difficult of description (the animals change vastly with age and the individual variation is excessive), the ranges would be equally difficult of description, and indeed these forms are not comparable with those recognized. They are mentioned because others have noticed them, and because there is here the beginnings of a differentiation which may in time rank with the other forms of the series.

The overlapping between *fuscus* and *phoca* can best be accounted for by the phenomenon of baseleveling. *Fuscus* lives more in open valleys, *phoca* in narrow ravines, in the territory they hold in common. They must have had an originally distinct range, so that once there was no overlapping between the *fuscus* of the plateau and the *phoca* of the mountains. With the broadening of the valleys, and the dissecting and narrowing of the mountains *fuscus* invaded the territory of *phoca*. This process is still going on.

Auriculatus and *brimleyorum* are peripheral forms which are connected with *fuscus*, *auriculatus* being the link between the two others.

The range of the four forms as a series is limited to the westward by the increasing aridity of the country, which is shown markedly by the replacement of forest by prairie. There are several indications that this limit was once further west than it is now. These are: 1. The apparent isolation and disconnected range of *brimleyorum*, which must have connected with the range of *auriculatus* in Arkansas or in Louisiana; 2. The data on the recent extermination of *fuscus* in Indiana (Gaines 1895, McAtee 1907, Hahn 1908), and its very local occurrence in Indiana and in Illinois; 3. A specimen of *fuscus*, apparently of authentic provenance, from Manitoba. The last may need confirmation, but all signs point to a former greater westward range

of the genus and hence to a formerly greater humidity. The date of this may very reasonably have been immediately after the retreat of the glacier.

Two forms of *Desmognathus* in the cold damp mountain forests are nearly terrestrial. They are the most specialized forms in the genus. The southern one, *carolinensis,* has been shown to intergrade with *fuscus* in North Carolina, and it intergrades with the northern *ochrophaeus* in West Virginia. Whether or not the northern *fuscus* intergrade with *ochrophaeus* is uncertain, but they apparently do not.

Pope has recently discovered almost perfect intermediates between *fuscus* and *carolinensis* and their breeding habits are similar to those of *fuscus,* but so far as I know no one has yet obtained any information on the breeding habits of the typical forms of either of these two more terrestrial races. Of the two *carolinensis* is the more primitive.

Leurognathus marmorata is externally very similar to *Desmognathus quadra-maculatus,* save that in color it has a light dorsal pattern much like that of *phoca.* The skull is quite different, and bears out what is known of the habits. There are no vomerine teeth, these being lost by the young of both sexes. The skull is extremely flattened, the internal nares are displaced and moved back and apart, and the premaxillary fontanelle is closed. All but one of the specimens with complete data were taken from the water.

The anatomical evidence shows it to be *absolutely aquatic.* The internasal glands function to provide a sticky substance to lubricate the tongue. These glands open to the tongue through the premaxillary fontanelle. This is of course useful only to animals seeking food on land, as most of our salamanders do. Now in *Leurognathus* the glands must be rudimentary as the nasals and vomers are almost in contact. The opening to the roof of the mouth is completely closed. The change in the position of the internal nares denotes alteration in the bucco-pharyngeal respiration practised by these animals. *Cryptobranchus,* also absolutely aquatic, is the only salamander with a similar skull. The vomerine teeth of *Leurognathus* are absent; those of *Cryptobranchus* are in the larval position, far forward. But the mechanical result is the same, the teeth in both are forward for raptorial action; there are none placed as are the large vomerine teeth in land salamanders, directly where the returning tongue will bring the prey. It is interesting to note that *Cryptobranchus* has retained several

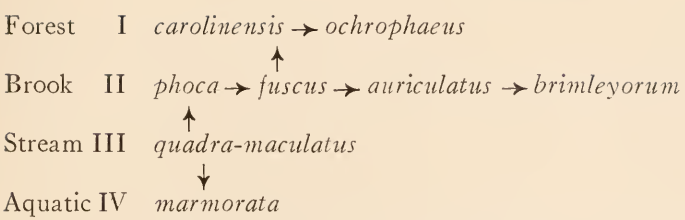
larval features in the course of its aquatic adaptation. The forward position of the vomerine teeth is such a retention. *Leurognathus* is fully adult in all characters.

Its relationships are unquestionably with *quadra-maculatus*. Its coloration, however, shows a certain resemblance to that of young *phoca*, and lends strength to the supposition that the early form of the group was colored as are young *phoca*.

The changes of vomerine teeth from form to form are remarkable in this group. Starting with a type *(quadra-maculatus)* in which these teeth are never lost (the typical amphibian condition), we have next one in which very old males lose them *(phoca)*, then others (rest of genus *Desmognathus*) in which these teeth are lost by the males at sexual maturity, but in which the females retain them throughout life; finally in *Leurognathus* neither sex has them after transformation — an excellent example of orthogenesis, or the progressive development of a character and of its being pushed ahead in ontogeny as progress is made in phylogeny. It is probable that the loss is independent in the two genera and is an instance of a tendency inherent in the chromatin cropping out in different places in the group. There are quite as remarkable steady developments of characters seen in other ways, as that of color pattern in the line *quadra-maculatus, phoca, fuscus, carolinensis, ochrophaeus*, or in the line *phoca, fuscus, auriculatus, brimleyorum;* or that of the hooking of the male jaw in the line *quadra-maculatus, phoca, fuscus, carolinensis, ochrophaeus;* or dwarfing in the same line.

The interrelationships of the different series of the group are not difficult of explanation save in one instance. The four series have each one originated as a single form from some form of one of the other series by crossing to a different ecologic niche, which was then followed as far as possible, the single form coming to be represented by several vicarious forms in outlying regions.

From anatomical evidence *carolinensis* of the first series is the link with the second series by means of *fuscus*. *Phoca* links the second series with *quadra-maculatus* and the latter is closest to *marmorata*.


Forest I carolinensis → ochrophaeus
Brook II phoca → fuscus → auriculatus → brimleyorum
Stream III quadra-maculatus
Aquatic IV marmorata

(Animals of Southern Blue Ridge in first column).

The above diagram shows briefly the course of evolution of the group, a number of major adaptive movements to fit various ecologic niches in the Southern Appalachians, together with several minor movements to fit the same ecologic niches outside that region.

It also calls attention to the one point unexplained under this hypothesis. This is that *carolinensis* is developed not from its mountain relative *phoca* but from *fuscus*. This is unquestionably sustained by the anatomical evidence.

The problem is: 1. Why did not *carolinensis* develop as a land dwelling form from *phoca?;* and 2. Why did it develop from *fuscus?* Something must have occurred which changed the usual course of events, which would have been for a land dwelling mountain form to develop from a brook dwelling mountain form and not from a brook dwelling plateau form.

To begin with *fuscus* is more of a land animal than is *phoca,* because though they inhabit the same ecologic niche *fuscus* lives in a drier climate than does *phoca.* Ecologically, therefore, as well as anatomically, *fuscus* is intermediate between *phoca* and *carolinensis. Carolinensis* lives not only on land but in a higher altitude and in a colder climate than does *fuscus,* where the ranges of the two meet. The factors then that distinguish the habitat of *carolinensis* from that of *fuscus* are lower temperature, greater humidity, greater altitude. Land life would be easier for an animal with the habits of *fuscus* in the southern Appalachians rather than elsewhere, on account of the greater humidity.

With these facts in mind baseleveling appears as the only suitable explanation. As the river valleys of the southern Appalachians began to broaden out, the *fuscus* of the plateaus to the east and west entered them and tried to extend into the mountains. Partly because the small streams were densely populated by the larger *phoca* and

partly because it was not a far cry from the drier climate brook banks of the plateau to the damp mountain forest an ecologic change took place and *fuscus* became *carolinensis*.

In brief the history of this group is a set of forms differentiated on a basis of ecologic isolation in the southern Appalachians. One of the ecologic niches thus occupied is of wide spread occurrence outside of this area and the animals known variously as *fuscus, auriculatus,* and *brimleyorum,* have differentiated outside of the mountains in three regions differing climatically and physiographically. Even in the mountains certain differences between the northern Appalachians and the southern have caused the differentiation of *ochrophaeus* from *carolinensis*. The southern Blue Ridge, which seems the center of origin, is much more humid than the rest of the Appalachians.

The primitive forms are *quadra-maculatus* and *phoca*. The end forms are *marmorata, ochrophaeus* and *brimleyorum*. These forms do not occur in the same regions. One is central and the other two are peripheral as far as the actual range of the group is concerned. The primitive forms are central. The dispersal of this group has apparently gone on under the pressure of overcrowding. It is worth noting that all of Adams' criteria are satisfied by the assumption that the southern Blue Ridge is the center of dispersal of this group.

The remaining genera lack the peculiar mechanical specializations of atlas, skull, and temporal muscles found in *Desmognathus* and *Leurognathus,* they never show any tendency to lose the vomerine teeth, and sexual dimorphism, when it appears, is different from that of the two genera just mentioned. The sexual dimorphism of male *Desmognathus* consists in elongated premaxillary teeth; loss of vomerine teeth; hooking of the jaw and loss of teeth at the hind end of the maxilla; and larger size. The sexual dimorphism of male *Hemidactylium, Eurycea,* and *Oedipus,* consists in elongated premaxillary teeth; swelling of the snout, especially below the nostrils; and smaller size. This is unquestionably acquired independently by the three genera mentioned, but parallelism indicates community of descent.

There are two main groups of genera, those of *Plethodon* and *Eurycea*. These are connected by three intermediate genera which hardly belong to either group. The *Plethodon* group cannot be derived from any existing genus. The most primitive genus is *Pletho-*

don itself. It occurs in various forms in the eastern United States, and is met with again on the Pacific Coast.

The most primitive group is confined to the East. It comprises the species *yonahlossee, wehrlei, glutinosus, jordani, shermani,* and *metcalfi.* Of these, *glutinosus* is the only one which occurs outside the mountains, and it covers the range of the genus in the east, except to the northwards.

The primitive characters in *Plethodon* are few costal grooves. long vomerine series, and presence of dorsal light markings. All the present group have 14 costal grooves except *wehrlei* which has 17. The longest vomerine series is possessed by *yonahlossee,* with *glutinosus* second. Light dorsal markings are found in *yonahlossee* and in *wehrlei.* The most primitive form is then *yonahlossee,* which has been found in a few places in the southern Blue Ridge. Related to it is the more elongate *wehrlei* of the northern Appalachian Plateau. *Glutinosus,* generally distributed, is about midway among these forms. *Jordani, shermani,* and *metcalfi* lack the white pigment spots of the first three forms. They occupy the higher ranges of the southern Blue Ridge, *metcalfi* being found on a number of ranges, *jordani* in the Smokies, and *shermani* in the Nantahalas. The three are very closely related.

One of the western forms, *vandykei,* is quite isolated from the other forms of the genus, by the possession of developed paratoid glands and webbed toes. It has 13 costal grooves and a light dorsal band.

The remaining forms have a light dorsal band, short vomerine series, and rather elongate bodies. The most primitive is *dorsalis* of the Middle West, which is closely allied to *cinereus,* a more elongate form of the North and East.

On the Pacific Coast *intermedius* is about on a par with *dorsalis* and *elongatus* is almost exactly like *cinereus.*

The relationship between *cinereus* and *dorsalis* is very close. *Intermedius* is not more allied to one than to another, and the resemblance between *cinereus* and *elongatus* is probably parallelism.

Dorsalis has the most primitive color pattern in this series, *intermedius* has the longest vomerine series, and *dorsalis* and *intermedius* have the shortest bodies.

There is not much that can be said as to the evolution of *Plethodon.* The *glutinosus* group evidently centers in the mountains, where three

forms of it may occur together. There are no observable ecological distinctions. The *cinereus* group is more northern than the *glutinosus* group, and it has no obvious center, being perhaps, the local differentiations of a single original form, as they have different ranges. *Vandykei* is probably closer to this group than to any other.

Modifications in *Plethodon* are either along lines of size (*yonahlossee, metcalfi, cinereus,* three sizes occurring together); or for lower humidity *(yonahlossee-glutinosus);* or of elongation and loss of pattern *(yonahlossee-wehrlei* or *dorsalis-cinereus);* or of purely local variation *(metcalfi, jordani, shermani).* Size differentiation, found in perfection in Northeastern weasels, occurs again in this family in the genus *Oedipus,* several species of the same genus occupying the same ecologic niche and differing mainly in size.

The original family pattern, consisting of paired dorsal light spots (the equivalents of the larval areas of a mountain brook ancestor), is present in young *yonahlossee* but in the adult it gives place to a diffuse dorsal band. In *P. wehrlei* these spots are occasionally present, but much smaller. The next most primitive pattern is the zigzag stripe of *dorsalis,* which gives place to the straight-edged stripe of *intermedius, cinereus, elongatus,* and *vandykei.* The other forms of the genus have no light dorsal markings. The manner of its final disappearance may be that seen in *wehrlei* where the insignificant spots of pigment are present or absent, or that seen in *cinereus,* where there are two color phases, one melanistic and without the stripe, and the other with the black pigment absent and red pigment present in a broad dorsal stripe; or that of *dorsalis,* where some of the older individuals have the stripe obscured by diffusion of dark pigment.

Ensatina differs from *Plethodon* chiefly in possessing a basal constriction of the tail, a provision for autotomy, and an additional adaptation to terrestrial life. It has a longer vomerine series and tubercles on the palm. Both these characters may be more primitive than those of *Plethodon,* and the two genera may have come rather from a common stock.

Two species, *platensis* of Uruguay and *croceater* of the Sierras, retain the primitive paired light spots on the back. The Coast Range species *eschscholtzii* has lost these.

The breeding habits of *Ensatina* seem to be slightly more specialized than those of *Plethodon.*

The close resemblance, amounting almost to identity, between *croceater* and *platensis,* which are so far apart geographically, is strong evidence of the great age of even specific characters in this group.

Hemidactylium differs from *Plethodon* anatomically in having only four toes, strong sexual dimorphism, and a basal constriction of the tail. These are all more advanced characters than those of *Plethodon.* Ecologically *Hemidactylium* is in a peculiar position. It has reverted to some extent to the still water breeding site of more primitive salamanders. The larva has a dorsal fin as do the larvae of *Pleurodelidae* and *Ambystomidae.* This is unique among Plethodont larvae. The eggs are single and deposited out of the water. The adult has more adaptations for terrestrial life than has *Plethodon,* and the life history is more aquatic. If derived from *Plethodon,* as the anatomical evidence would seem to show, it must have diverged at a time when *Plethodon* had more primitive habits than it does now.

The form has a wide general range in the East, but seems more abundant in the glaciated regions, where its peculiar ecological requirements are more frequently met.

Aneides shows a great advance on *Plethodon* in the Y-shaped terminal phalanges, the partly edentulous maxilla, the single premaxilla, and the enlarged maxillary and mandibular teeth. It is largely arboreal, and the peculiar phalanges may be taken as adaptations to that habitat. The eastern form, *aeneus,* is the most primitive. On the Pacific Coast are three forms. One, *flavipunctatus,* has the primitive unflattened teeth of salamanders in general, as does *aeneus.* It has however, the most elongate body in the genus, and this elongation is usually secondary. It occurs in the same regions as does *lugubris,* and there is no evidence for its being arboreal. The other two, *lugubris* the more southern, and *ferreus* the more northern, have practically distinct ranges and are very closely allied. Of the two, *ferreus,* which has almost the same coloration as *aeneus,* seems slightly more primitive. These two are known to be arboreal. In the genus as a whole, there is a fairly clear line of evolution from *aeneus* through *ferreus* to *lugubris,* with *flavipunctatus* as an aberrant offshoot from some form more primitive than exists today in the West. The embryoes of *lugubris* have peculiar allantoic gills while in the egg, structures unique among salamanders.

Batrachoseps is an elongate, degenerate form derived from *Plethodon*. The forms all occupy mutually exclusive territory and are evidently local modifications of a single original type. This is best represented today by *pacificus* of Santa Cruz Island, which is somewhat reminiscent of *Plethodon intermedius* or any generalized member of the elongate group of *Plethodon,* from which the genus evidently stems. Ecologically, this elongate type is a further advance in terrestrial adaptation and bespeaks a burrowing mode of life.

The *Plethodon* group as a whole has traveled further by dint of its terrestrial habits than the *Desmognathus* group. The genus *Plethodon* itself is best developed in the East, *Hemidactylium* is not found in the West, and the most primitive forms of *Plethodon* and of *Aneides* are found in the East. *Batrachoseps,* which is restricted to the West, seems more modern than the other genera, and to have undergone less individual development, as its generic history is merely the local modification of a single form. The eastern origin of the *Plethodon* group seems to be the only logical explanation of its present status.

Two genera with tongues attached in front, *Stereochilus* and *Typhlotriton,* seem otherwise more nearly allied to the *Eurycea* or free-tongued group than to the *Plethodon* group. They have single premaxillae, and the vomerine and parasphenoid tooth areas are continuous, a combination of a secondary and a primitive character. Ecologically the first is a dweller in the muddy banks of coastal ponds, and the other a cave form of the Ozark region. Both have aquatic larvae of typical Plethodont conformation. They are evolutionally not altogether primitive, and stand between the *Plethodon* and *Eurycea* groups as modified descendants of the ancestors of both, albeit somewhat closer to the second.

Typhlomolge seems to me to be a permanent larva. Among larvae its closest ally is the larva of *Typhlotriton,* and in the absence of any evidence to the contrary, this may be taken as a statement of its relationships.

These three isolated forms are surviving in ecologic crannies on the outskirts of Appalachia. A mud lurker and two cave dwellers, they are apparently relics of the early days of the family and offer their own evidence as to its origin in Appalachia.

The history of the *Eurycea* group is that of the family. What we have in miniature in the *Desmognathus* group, or minus the early

stages in the *Plethodon* group, is exemplified by many forms and in all stages in the series of species from *Gyrinophilus danielsi* to *Oedipus alfaroi* or to *Oedipus pennatulus*.

Of the whole array *Gyrinophilus* and *Hydromantes* alone possess the primitive double premaxillae. *Hydromantes* has numerous specializations. The loss of the prefrontals, the webbed toes, lack of continuity between vomerine and parasphenoid tooth rows, sexual dimorphism, and lack of aquatic larvae, are all characters in which it is certainly not primitive as compared with *Gyrinophilus*.

This combination of primitive and specialized characters bespeaks a long period of independence and isolation for *Hydromantes* which is amply confirmed by its geographical position. *Gyrinophilus* is then the most primitive of the free-tongued salamanders. Its ecological relationships bear this out for it is a dweller in mountain brooks, and leads a very active existence both as larva and as adult. The two species are very closely allied and it is not easy to tell which is the more primitive. The coloration of *danielsi* is nearer that of *Pseudotriton* and of *Eurycea* and it may be the older of the two. There is no particular problem in the distribution of these two forms. They occupy the same ecologic niche in two adjacent regions, and offer an excellent example of typical vertebrate speciation. The difference between their two ranges is the greater humidity of the southern Blue Ridge.

The species of *Pseudotriton* are, except for *Gyrinophilus*, the only free-tongued salamanders which show no sexual dimorphism. Again, except for *Typhlotriton*, *Gyrinophilus* and *Stereochilus*, they are the only *Plethodontidae* which retain the primitive continuous vomero-parasphenoid tooth row, and *Pseudotriton*, *Plethodon* and *Ensatina* are the only members of the family to have the prefrontal border the naris, a primitive character. They are unique in their meeting nasals. All in all they represent a more advanced stage than *Gyrinophilus* and occupy a different niche. They inhabit springs. *Montanus*, the more specialized, is a mud burrower, while *ruber* is not. Yet there is apparently some competition, as the ranges overlap but do not coincide, and where one is common the other is rare. (Although they have both been taken at the same spring). *Montanus* seems to be on the wane from its scattered occurrence to the northwards. *Ruber* to the southwards shows a rather definite limit, the inner edge of the Coastal Plain. I think we have in this genus an original southern low

country form and a northern upland form. There has been a period of expansion of the southern form (possibly coincident with retreat to the mountains of the northern form), followed by the present period of retreat before the northern form which is in progress. The range of the genus barely crosses the terminal moraine to the northwards. It is quite possible that the retreat of *ruber* before the ice was also the time of the retreat of *montanus* before *ruber* and that the two had separate ranges in pre-glacial times. Though again the conditions immediately after the ice may have been such as to favor invasion northwards by *montanus* and now the tide has turned in the other direction and only a few survivors in isolated stations tell the story of incursion and withdrawal.

Indeed, *montanus* seems on the highroad to extinction and may only survive in the Gulf-coast race *(flavissimus)* on whose lands *ruber* has not yet entered. The typical form *(montanus)* seems split into an Eastern and Western colony and over nearly the whole of its range *ruber* has been found. So far the slight ecological difference between them has sufficed to preserve *montanus* but the hands of man and of nature are both against it, draining out the muddy *montanus* springs into *ruber* springs and by both draining and erosion depressing the scales still further in favor of *ruber.*

The hypothesis of a postglacial advance and retreat of *montanus* is supported by the somewhat similar case of *Desmognathus fuscus* (see above) and is perhaps the more plausible of the two. The races of *ruber* and of *montanus* are, like the two species of *Gyrinophilus,* local modifications. The same niche in a different region. Of these five races *montanus* is more primitive than *flavissimus* and although there is little to choose between the races of *ruber,* yet the mountain forms show certain more primitive features.

The species of *Eurycea* show little ecologic segregation among themselves. Perhaps this is the reason why they alone among the genera of *Plethodontidae* exhibit centrifugal dispersal, and have spread in three successive waves, so that the center of the group range contains less forms than do some more peripheral situations. Without ecologic segregation there must be competition; with competition there must be either migration or extermination.

There are three groups, *bislineata-multiplicata; longicauda-melanopleura-gutto-lineata-quadridigitata-remifera; lucifuga.*

Their habitat preferences are not marked save in a few instances. *Bislineata* is for running streams, *longicauda* for springs issuing from rock, *gutto-lineata* for muddy ditches or rock springs, *melanopleura* and *lucifuga* are said to prefer caves. But almost any small spring or stream in the animal's range is utilized. The cave habitat of *melanopleura* and of *lucifuga* (and of *longicauda* as well in those localities) is best explained by the fact that most of the small springs and brooks in their range are cave springs and cave brooks. Where there are springs and brooks outside of caves in their range the animals occur there as well as in caves.

It is rather difficult to trace the course of evolution in this genus. The only thing we can assert is that *quadridigitata* is a terrestrial offshoot of *gutto-lineata*. Sexual dimorphism fails us, for one race of *bislineata* lacks cirri and two have them. In general the more southern forms have the greatest sexual dimorphism.

Lucifuga has the least primitive coloration. The family color pattern is based on six rows of unpigmented areas in the larva. Now while these areas are present in *lucifuga* larvae there is little trace of their influence in the adult markings. Spotting antedates striping in Plethodont salamanders, as shown by the pattern development in *Desmognathus,* and the larval (and hence the adult) pattern of *bislineata* and of *multiplicata* is thus more primitive than that of the *longicauda* series. When we find that the forms with the most primitive color pattern are also the forms which are at the periphery and absent from the center of the group range, it is rendered quite probable that *bislineata* and *multiplicata* are the first wave of dispersal of the genus. Apparently the center is in the Middle West, in the region from which these two are absent. They have been dwarfed in their journeyings. That peculiar elongation (cf. *Batrachoseps, Plethodon cinereus,* "*Oedipina*") which has cropped out in many Plethodont salamanders is well under way in both. But *bislineata* shares with *Desmognathus fuscus* and *Plethodon cinereus* the greatest range and greatest abundance in numbers of individuals found in the family. Its wide range over different regions has occasioned the growth of local races, of which three are easily recognizable. One for the far South, one for the stronghold of the Plethodonts, the southern Blue Ridge, and one for the North. But just as in the case of *Desmognathus fuscus* there is an incipient division of the typical Northern race into a

Northern and Central race. These differences are most evident to anyone who is well acquainted with the two animals at one place and who then meets them elsewhere. Dr. H. H. Wilder who has had a life-long knowledge of *fuscus* and *bislineata* in Western Massachusetts, has often remarked to me on his first meeting with these animals near Philadelphia and of the difficulty he had convincing himself that they were the same as the Massachusetts ones; and I have had nearly the same experience with the localities reversed. Yet these incipient races are by no means so well marked as those recognized in the nomenclature and are practically impossible to define or map. That the differences are real I have no doubt, but most of them disappear in preserved specimens. Excellent examples of the most subtle *"Habituëllen-merkmalen."*

In this group we meet the same sexual dimorphism as in *Hemidactylium scutatum*. In its most primitive form it consists in the swelling of the snout of the adult male. Even this is sufficiently marked to be an excellent external character for sex. Along with this is dimorphism in size. Contrary to the *Desmognathus* standard, here the male is the smaller. Next the swelling increases and the edges of the naso-labial groove extend downwards in a tubercle, this frequently is prolonged into a cirrus or barbel, whose tip is free from the lip and hangs down on each side like the tusks of a male walrus. The teeth on the premaxilla become reduced in number to a few quite large ones which are forward out of line with those in the maxilla and which separately pierce the lip and are in plain sight even when the mouth is closed. Last of all the teeth on the maxilla also become large and few but do not pierce the lip. This is seen only in *Oedipus chiropterus* and in *Hydromantes platycephalus*. In the latter the premaxillary teeth do not pierce the lip. The greatest development of the cirrus is in species of *Eurycea,* the most swollen snouts occur in species of *Oedipus*. Conjecture offers no explanation of the function of the male characters in these salamanders. Much work has been done on the habits of *fuscus* and of *bislineata,* but nothing so far offers the slightest clue to the meaning of these equally bizarre and totally different sets of dimorphisms. Yet so little is known of even the commonest species that we need feel no surprise at ignorance concerning the function of characters which have only been described comparatively recently. Even the eggs of only a few species have ever been seen, and where

these are not known how can the more subtle matters of the breeding habits be explained. (It will be remembered that sexual dimorphism similar to that of *Oedipus* is found in *Hemidactylium*. Here there can be no question of relationship as *Hemidactylium* has the tongue rather broadly attached in front). *Gutto-lineata, melanopleura,* and *longicauda* are probably offsprings of a common ancestor as it is difficult to derive one from the other. Their ranges are contiguous and scarcely overlapping save in the case of *gutto-lineata* and *longicauda*. And this seems to be invasion by *longicauda* from the Valley into Blue Ridge or Coastal Plain, except in the neighborhood of Anniston, Ala., where *gutto-lineata* holds true valley territory.

Northward *longicauda* is stopped by those places where terminal moraine and drainage divides coincide. Apparently it can cross either but not both. A dwarfed terrestrial offshoot of *gutto-lineata* is *quadridigitata,* which has nearly the same range but more terrestrial ecological proclivities. It has an East Floridian race, *remifera*. *Lucifuga* stands alone. It is the most modified of the species.

This genus has evidently evolved in a different way from those we have previously examined. The passage from one group of *Eurycea* to another is unexplained on ecological or geographical grounds. It is an example of centrifugal dispersal in which the primitive forms are on the periphery and the specialized form in the center.

The last two genera of the family are terrestrial. Their distribution, which is discontinuous, is from California to Bolivia and Southern Europe. That these two genera, *Hydromantes* and *Oedipus* form a natural group contrasted with that formed by *Gyrinophilus, Pseudotriton* and *Eurycea* is shown by their anatomy, habits, and distribution.

Hydromantes and *Gyrinophilus* both have double premaxillae and are evidently both primitive in that respect. It is impossible to derive *Hydromantes* from any existing genus and these two have sprung rather from a common ancestor. There can be no alliance between *Hydromantes* and *Oedipus* except the common origin of the two from some terrestrial stock. Some *Oedipus* have prefrontals, which bones are lacking in *Hydromantes;* some *Oedipus* have the toes less webbed than do the species of *Hydromantes*. Two characters show clearly the more primitive aspect of *Hydromantes,* the non-constricted tail and the double premaxillae. But many characters, as tendency to loss of

prefrontals and loss of septomaxillae, weakening of premaxillae, webbing of toes, color pattern, enormous nostrils of young, terrestrial habits, etc., clearly show the relationship between the two genera. These two genera, terrestrial as are all groups of the family which have wandered far from Appalachia, presumably originally held land to the west and north of the center. Those in the west spread southwards and in the Pliocene into South America. Those in the north went east into Europe. Glaciation and other causes have brought about the present discontinuity.

Hydromantes, whose three species have been separated by movements of ice and of earth is today a relict genus.

The most primitive of its species is *H. italicus* of Italy, and *genei* of Sardinia is perhaps closer to *platycephalus* of California than to *italicus*. The genus must have been more widely dispersed in Europe and probably has recently become extinct in Corsica. Continental glaciation coming from the North, and east-west mountain systems have together been responsible for much extinction in Europe and may reasonably be considered guilty in the case of other *Hydromantes* in northern Europe. For the genus must have come to Europe from America, not over a mythical Atlantis, but far to the North, across Greenland and Iceland. We are led to this conclusion by the discovery of a *Hydromantes* in California. And the evidence for Atlantis in this instance rests on *infuscatus* of Haiti, which, if it is anything but a misplaced label, is an *"Oedipina"* rather than a link between *Oedipus* and *Hydromantes*.

To the South lies *Oedipus,* from Mexico to Bolivia. Allied to *Hydromantes*, it is a large, modern genus of some 30 species. The extremes are quite different but there are many connecting links.

The most primitive species seem to be those which have prefrontals, a groove from eye to gular fold, least webbed toes, long vomerine series, parasphenoids in two patches, fully dentate maxilla, small nostrils as adults, non-wormlike shape, and a coloration of paired dorsal spots or the somewhat less primitive light dorsal band.

They fall into the following groups, which would, if distinct enough and in the absence of annectant forms, rank as genera.

I. The primitive group, all mountain forms, leading to II, III, and IV. This contains the species *bellii, schmidti* and *robustus; cephali-*

cus, rostratus, morio, subpalmatus, and *adspersus; sulcatus, chiropterus,* and *rex.*

II. The small mountain forms with large nostrils, *"Thorius"* of Cope. The species are *townsendi, pennatulus, nasalis,* and *picadoi.*

III. The species with fully webbed toes, almost all low country forms. These are *altamazonicus, platydactylus, salvinii, attitlanensis, lignicolor, yucatanus, striatulus, colonneus,* and *rufescens.*

IV. The wormlike forms, low country species with elongate bodies and weak limbs, usually lacking sexual dimorphism and the basal constriction of the tail. *"Oedipina"* of various authors. The group includes *lineolus, complex, uniformis, collaris, parvipes,* and *alfaroi.*

Four species, *pennatulus, colonneus, rufescens,* and *alfaroi* have no teeth on the maxilla. Not so long ago this character was held to be of even family importance in *Amphibia,* but I cannot see any reason to consider these species as differing sufficiently to merit generic rank.

The large, spotted form of the Mexican mountains, the "tlaconete," *Oedipus bellii* is the largest member of the family and the most primitive member of the genus. In the mountains of Honduras occurs *schmidti,* and in Costa Rica *robustus.* These two are nearly allied to each other and are less primitive than *bellii.*

A somewhat similar series of forms extends from Mexico to Colombia, with the most primitive, *cephalicus,* in Mexico, and the most specialized, *adspersus, in Colombia. Rostratus* from Guatemala, *morio* from Honduras and Guatemala, and *subpalmatus* from Costa Rica, fill up the anatomical and geographical gaps. *Cephalicus* is the most distinct, the last four being quite closely allied to each other.

In both these series the Mexican form has nearly free toes, while the most southern species have the toes almost entirely webbed. The two series differ considerably in size, the *bellii* series being all very large, the *cephalicus* series being of medium size.

The relationships of the small mountain forms are less easy to determine. The most primitive are *sulcatus* from western Mexico and *rex* from Guatemala. The eastern Mexican form, *chiropterus,* is allied to *pennatulus,* a highly specialized form with large nostrils. The other eastern Mexican form with large nostrils, *townsendi,* is not so clearly derived from *chiropterus,* and seems rather related to the more primitive *sulcatus.* The southern species with large nostrils, *nasalis* of Honduras and *picadoi* of Costa Rica are closely related to each other,

picadoi being clearly derived from *nasalis*. It is highly probable that the "*Thorius*" forms do not constitute a natural group, and that the relationships run *sulcatus-rex-nasalis-picadoi, sulcatus-chiropterus-pennatulus,* and possibly *sulcatus-townsendi.* This arrangement satisfies the anatomical and geographical requirements.

In all these mountain forms we have to note mainly the effects of isolation and of an evolutionary process whose results are orthogenetic, as if each successive isolated mountain mass brought out a further character.

There are several cases where forms of the various series occur together. *Bellii, cephalicus, chiropterus,* and *pennatulus* (or *townsendi*) in Mexico; *schmidti, morio,* and *nasalis* in Honduras; *robustus, subpalmatus,* and *picadoi* in Costa Rica. There are no marked ecological differences. *Pennatulus* and *townsendi* seem addicted to the space between bark and wood of logs, *morio, nasalis,* and *picadoi* to Bromeliads, but the rest live generally under debris as does *Plethodon.* The differences seem mainly those of size between forms occurring together, as is seen in the case of weasels in the Northeast, or *Plethodon* in the southern Blue Ridge. The concomitant southern species are of course descended each from one of the Mexican forms, but the initial divergence seems the result of neither ecological nor geographic isolation, and size differentiation seems the best solution.

In general the mountain forms indicate an advance south in the mountains with specialization increasing as the advance went on.

The low country species are much more difficult to interpret. They are much rarer in collections, and have individually wider ranges.

The form of the east face of the Andes, *altamazonicus,* is very close to the end member of the *cephalicus* group, *adspersus,* and from geographical probabilities may be regarded as derived from *adspersus.*

Platydactylus, salvinii, attitlanensis, lignicolor, and *yucatanus* are fairly closely allied and seem to cover the low rain forest area with little or no overlapping of ranges. The first three are particularly close, *attitlanensis* being a mountain form of *salvinii. Salvinii* is on the Pacific Coast from Costa Rica to Tehuantepec. The more inland and southern specimens of *platydactylus* are more like *salvinii* than are those from Tehuantepec, where the ranges of the two approach closely but where the forms remain very distinct.

This would seem to indicate a southern origin and an advance

northwards, and indeed there is considerable possibility that while the mountain forms have migrated south increasing in specialization as they migrated after the fashion of many animals of similar origin, the low country forms may have joined the stream of immigrants from South America and advanced northward to the east and to the west of the Cordillera advancing in specialization as they went. *Lignicolor* and *yucatanus* have certain characters in common and *yucatanus* is the more northern and the more specialized. These are all fairly large forms and may be local modifications of a single wide ranging species, or *lignicolor-yucatanus* may be a parallel series to *salvinii-platydactylus*.

The smaller forms, *colonneus* of Panamá, *striatulus* of Costa Rica and Nicaragua, and *rufescens* of Guatemala and Mexico, have no immediate relationship to the larger forms of the *platydactylus* group, *striatulus* being the most distinct, and *rufescens* and *colonneus* showing some resemblance to each other and to *altamazonicus* of South America.

Here again the lines of relationship seem to converge to the regions south of Mexico rather than to the Mexican mountains as they did in the mountain forms.

Rufescens and *colonneus* have no maxillary teeth and are the most specialized of the typical, web-footed *Oedipus*.

The worm-like forms are all low country creatures and little can be said about their evolution. The blunt snouted forms with large eyes, are represented by *lineolus* of Mexico with 14 costal grooves, *complex* of Panamá with 17, and *uniformis* of Costa Rica to Honduras with 19.

The sharp snouted forms with small eyes are *collaris* of Panamá to Nicaragua, a large form with 19 costal grooves; *parvipes* of Colombia and Panamá with 17; and *alfaroi* of Costa Rica with 20.

Complex and *uniformis* are closely related, and *parvipes* and *alfaroi* form a similar pair. In each case the more primitive form is southern, the more specialized is northern. In this group of "Oedipina" as in the web-footed forms, the lines of relationship converge towards the southern part of Central America, and the center of origin and dispersal may well have been there.

To sum up the apparent evolution of *Oedipus:* There was an original splitting on lines of size in the Mexican mountains; members of these groups wandered south along the mountains becoming more

specialized; the members of the smallest sized group produced various forms with large nostrils; the members of the medium sized group produced various forms with fully webbed toes which left the mountains; these web footed species center in the region of Costa Rica and Panamá; from some unknown type the worm-like forms arose, also centering in the region of Costa Rica and Panamá; the low country forms, therefore, seem to have had a different center of dispersal from that of the more primitive mountain types.

GENERALIZATIONS

The observed facts of anatomy, distribution, and ecology suggest certain biological generalizations.

These are:

I. The precedence in time of Function over Form.

This is well seen in most of the cases where Form can be interpreted in terms of Function.

1. Lunglessness and its concomitant modifications. An adaptation to mountain brook life, unquestionably acquired *after* entrance into the habitat. It is found in varying stages in *Hynobiidae (Onychodactylus); Ambystomidae (Rhyacotriton); Pleurodelidae (Neuergus, Euproctus, Salamandrina); Salamandridae (Chioglossa);* all *Plethodontidae.*

2. Shifting of the position of the choanae and closure of the premaxillary fontanelle in *Leurognathus.* Aquatic adaptations, the animal being derived from an aquatic *Desmognathus* with normal choanae and open fontanelle.

3. The basal constriction of the tail in *Hemidactylium, Ensatina,* and *Oedipus.* This is an adaptation to terrestrial life after entrance into the habitat. The three genera are independently derived from terrestrial stocks with poison glands in the tail but with no provision for autotomy.

II. Parallelism, or the appearance of similar modifications independently in related animals. The same sexual dimorphism appears independently in *Hemidactylium, Typhlotriton, Eurycea* and *Hydromantes-Oedipus.*

III. Orthogenesis, or progressive development of single characters in genetic lines. The development of foot webbing in *Oedipus* in the line *cephalicus, rostratus, morio, subpalmatus, adspersus, altama-*

zonicus. The development of sexual dimorphism in *Desmognathus* in the line *quadra-maculatus, phoca, fuscus, carolinensis, ochrophaeus*. The development of color pattern in *Desmognathus* in the same line, or in the line *quadra-maculatus, phoca, fuscus, auriculatus, brimleyorum*.

IV. Jordan's Law of Vertebrate Speciation, that isolation is a condition of species formation in Vertebrates, the nearest relative of any given form being found not in the same region but in an adjacent region. This holds for nearly all the cases of speciation in the family, with the exception of a few where the nearest relative is in the same region but not in the same habitat *(Desmognathus)*, or *(Oedipus, Plethodon)* where the nearest relative is in the same region and the same habitat but of a quite different size.

V. Osborn's Law of Adaptive Radiation. That descendents of a single stock will, if unchecked, eventually fill all available habitats in any given region. Exemplified especially by *Desmognathus-Leurognathus* in the southern Blue Ridge.

These five generalizations deal rather with effects than with causes. They are the result of the method of evolution, whatever it may have been. But Parallelism and Orthogenesis indicate influence of the heredity-bearing material, just as surely as Jordan's Law, Osborn's Law, and the precedence of Function over Form indicate influence of the Environment.

No theory of Evolution which does not take both into account, or which does not admit that environmental influences may initiate chromatin changes can ever be sufficient to account for the present state of the Salamanders of the family *Plethodontidae*.

HISTORY

The history of the group starts with Palisot de Beauvois who collected in the United States in the later years of the eighteenth century. He took the first specimens of what Sonnini in 1802 called *Salamandra rubra* and thereby introduced the family to science. Green in 1818 described the commoner eastern forms, and from then on species have been added. The first genus was the obscurely published *Eurycea* of Rafinesque (1822). The family was founded in 1850 by Gray on the dentition, although he included also certain *Ambystomidae*. Cope (1889) recognized three families of salamanders with patches of teeth

on the parasphenoid bone, the *Plethodontidae,* the *Desmognathidae,* and the *Thoriidae,* on degree of ossification of vertebrae and of carpus and tarsus, grounds which are now felt to be insufficient. Stejneger and Barbour in 1917 proposed a fourth family for the genus *Typhlomolge,* based on the permanent retention of larval characters.

Cope in 1869 recognized 13 genera and 40 species. Boulenger in 1882 recognized 7 genera and 43 species. This is the most recent complete review of the group and as such its basis demands attention. Boulenger actually saw less than 200 specimens, and knew from examination 28 species. He recognized 7 genera, but the species he saw represent 11 of the modern genera.

The present review is based on over 12,600 specimens. 85 forms have been examined, including representatives of all the 15 genera recognized. Only one recognized species has not been examined.

Cope in 1889 revised the genera, and gave an account of the species in the United States. Günther (1900) considered the Central American forms.

Moore in 1900 showed that the difference between amphicoelous and opisthocoelous vertebrae was a matter of individual age, and that systematic divisions based on this character were worthless.

The absence of lungs was first noticed by Rathke in 1833 in *Batrachoseps attenuatus.* Wilder in 1894 showed clearly, however, for the first time that the lack was normal and widespread. Mrs. Wilder worked out the related mechanism of the naso-labial groove in 1906, and in the same year showed that *Desmognathus brimleyorum* had rudiments of the ypsiloid mechanism, present in lunged salamanders. Lönnberg, in 1899, first suggested that lack of lungs was due to lack of need for a hydrostatic apparatus, an idea also stated by Mrs. Wilder and myself in 1920.

Rathke in 1833 figured the enlarged premaxillary teeth of the male in *Batrachoseps attenuatus;* Green in 1820 described *Eurycea bislineata cirrigera* and thus mentioned the cirri of the male; Cope in 1889 pointed out that certain forms of *Desmognathus* occasionally lack vomerine teeth; but none of these structures was known to be restricted to the adult male until I began this work.

Cope discovered the difference of the male mandibular dentition of *Desmognathus ochrophaeus,* and Camp described the male maxillary

dentition of *Hydromantes platycephalus* as different from that of the female.

The use of evidence from this group to support general schemes of distribution has been slight, and restricted to a single case. That was the announced discovery of a salamander in Haiti, related both to Central American and to European forms. This along with other similar cases was held to indicate a former land connection between Central America and Southern Europe by way of the West Indies. As a matter of fact, the European forms are closely related to a California species rather than to the Central Americans; the Haitian salamander was a member of the Central American group which is most degenerate, least primitive, and least allied to the European species; and it probably is really a mislabeled specimen of a Mexican form.

The habits of the family have become gradually known. Baird in 1849 described the eggs of *Desmognathus fuscus;* in 1865 Verrill described the eggs of *Eurycea bislineata* and Putnam those of *Plethodon cinereus;* while in 1896 Berg showed that *Hydromantes italicus* was viviparous. Other discoveries of breeding habits have disclosed no fundamental differences.

The habitats of the common eastern forms have been known since their first descriptions appeared. Among the more recently discovered and more peculiar habitats may be mentioned the cave dwelling *Typhlotriton* and *Typhlomolge,* announced by Stejneger in 1892 and in 1896 respectively; the arboreal *Aneides lugubris,* described by Ritter and Miller in 1903; the aquatic *Leurognathus marmorata* (Moore 1899); and the Bromeliad inhabiting *Oedipus picadoi* (Picado 1913).

ANATOMY

Before taking up the family and the genera in a systematic manner, it may be well to review briefly the significant features of the anatomy and the variations thereof.

The skull is of a reduced Salamandroid type, and the primitive characters, such as free lachrymals, postfronto-squamosal arches, T-shaped parasphenoids, long maxillae, and posteriorly projecting prevomers are absent.

The lower jaw is formed by dentary, coronoid, and angular-prearticular, in the larva. At transformation the articular ossifies, and the coronoid disappears. Dentary and coronoid bear teeth.

The teeth on the dentary are in general like those on the maxilla. In certain male *Desmognathus,* however, the posterior part of the dentary is without teeth, and the hindermost teeth of the row are elongated.

The premaxillae have long nasal processes, which are primitively separate and enclose an opening, the premaxillary fontanelle. *Plethodon, Hemidactylium, Ensatina, Gyrinophilus* and *Hydromantes* show the primitive condition. In many forms the nasal processes fuse, and in *Leurognathus marmorata* the fontanelle is closed. The fusion or separation of the nasal processes is constant save in *Eurycea* where it is merely individual variation (Wilder 1924, *Eurycea bislineata bislineata*). The premaxillae are primitively separate, but in most genera they are fused together. The premaxillary dentition is specialized in almost all males, being composed of longer and more pointed teeth. It does not share in the specialization of the maxillary and mandibular teeth of *Aneides.*

The nasals are always present, and separated by the nasal processes of the premaxilla, save in *Pseudotriton,* where they are larger and meet in the median line over the fused nasal processes.

The frontals and parietals are always present, but in *Batrachoseps* and in some *Oedipus (pennatulus, uniformis)* there is a tendency for the latter not to ossify.

The prefrontal in its primitive form occupies the combined position of prefrontal and lachrymal in the *Hynobiidae,* and extends from orbit to naris. This occurs in *Plethodon, Ensatina, Gyrinophilus* and *Pseudotriton.* In most the prefrontal is excluded from the naris and forms a part of the orbital border. In a number of forms it is completely absent.

The absence of the prefrontal is characteristic of *Desmognathus, Leurognathus, Batrachoseps,* and *Hydromantes.* It is absent in some species of *Oedipus* and much reduced in others.

The septomaxilla has been found in all forms which have been examined except certain *Oedipus.*

The maxilla is normally short. The only significant variation is in *Aneides,* where the posterior part is edentulous and has a sharp alveolar edge which is on the same level as the tips of the teeth on the more anterior part. Correlated with this the teeth on the anterior part are long, and, in *lugubris* and *ferreus,* flattened and knife-shaped.

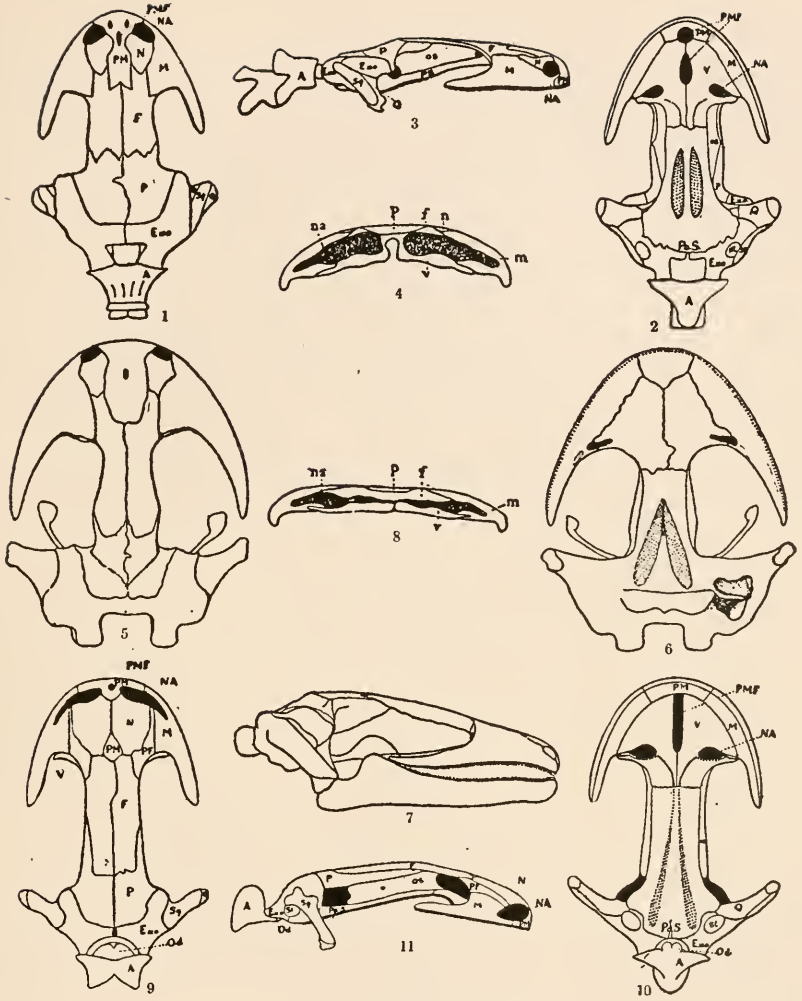


FIG. 1. — DORSAL VIEW OF SKULL OF DESMOGNATHUS FUSCUS FUSCUS, X 3. A, ATLAS; EXO, PERIOTIC; F, FRONTAL; M, MAXILLA; NA, NARIS; N, NASAL; P, PARIETAL; PM, PREMAXILLA; PMF, PREMAXILLARY FONTANELLE; Q, QUADRATE; SQ, SQUAMOSAL.

FIG. 2. — VENTRAL VIEW OF SAME (TEETH DIAGRAMMATIC); OS, ORBITOSPHENOID; PAS, PARASPHENOID; ST, COLUMELLA+OPERCULUM; V, PREVOMER.

FIG. 3. — LATERAL VIEW OF SAME.

FIG. 4. — A SECTION OF THE SKULL OF DESMOGNATHUS QUADRA-MACULATUS TAKEN JUST ANTERIOR TO THE INTERNAL NARES, X 3.5. P. PREMAXILLA.

FIG. 5. — DORSAL VIEW OF THE SKULL OF A FEMALE LEUROGNATHUS MARMORATA, X 3.2.

FIG. 6. — VENTRAL VIEW OF SAME. THE INTERNAL NARES ARE BLACKENED, AND THE POSITION OF THE ACTUAL CHOANAE IN THE ENTIRE HEAD IS INDICATED BY A ROW OF DOTS.

FIG. 7. — LATERAL VIEW OF THE SAME.

FIG. 8. — A SECTION OF THE SAME TAKEN JUST ANTERIOR TO THE INTERNAL NARES, X 3.5.

FIG. 9. — DORSAL VIFW OF THE SKULL OF PSEUDOTRITON RUBER RUBER X 3. OD, ODONTOID PROCESS OF ATLAS; PF, PREFRONTAL.

FIG. 10. — VENTRAL VIEW OF SAME (DENTITION DIAGRAMMATIC).

FIG. 11. — LATERAL VIEW OF SAME.

Figures 1-3 and 9-11 by the author and are reproduced from the Proc. U. S. Nat. Mus., 53, p. 396, 1917; figures 4-8 are by Dr. J. P. Moore and are reproduced by his kind permission from the Proc. Acad. Nat. Sci., Philadelphia, 1899, pl. XIV.

The normal maxillary teeth are pointed, but they are blunt, with a horizontal cutting edge in some *Desmognathus*. In certain *Oedipus* the maxilla is entirely edentulous.

The prevomers are present in all forms. The internal naris is a notch in the outer, posterior corner of this bone in all forms except *Leurognathus* where the naris is a small foramen enclosed between maxilla and prevomer. The teeth on the prevomer of larvae are anterior in position and parallel the premaxillary tooth row. In adult life they form a row along the posterior edge of each bone, much as in *Dicamptodon*, of the *Ambystomidae*. They are absent in adult males of some *Desmognathus* and in adults of *Leurognathus*. Primitively they are long and continuous with the patches on the parasphenoid, which patches have been shown by Mrs. Wilder (1920, Anat. Rec. 17, p. 349) to be outgrowths from the prevomer which later become separate, and thus have nothing to do with the parasphenoid but are homologous with the long posterior projections of the prevomer of *Salamandra*. The vomerine tooth rows are longest in *Ensatina*, *Hydromantes* and certain *Oedipus*, but in these they do not connect with the parasphenoid patches, and hence probably their extension towards the median line is secondary. The parasphenoid patches are always present. Primitively they are separate patches and connect with the vomerine rows as in *Gyrinophilus*, *Pseudotriton*, *Typhlotriton* and *Stereochilus*. In other genera this connection is lost, and the end form is a single patch formed by the original two.

The parasphenoid shows no significant variations. The periotic, the result of the fusion of proötic, paroccipital and exoccipital, is never composed of separate bones even in the larva. It bears crests in *Aneides*, *Gyrinophilus* and *Pseudotriton*. It is, of course, always present. The condyles are sessile in most forms but in *Desmognathus* and in *Leurognathus* they are projecting.

The otic apparatus is normally composed of columella and operculum both. They are fused together, and in the normal apparatus of the adult the plate-like portion is the operculum and the projecting rod is the columella. The operculum is attached by a narrow isthmus to the periotic. This is a modification of the primitive condition (which still exists in *Hynobius* and in *Rhyacotriton*) where the columella has a plate-like expansion and both it and the operculum help fill the fenestra. In *Batrachoseps* the operculum is not attached

to the periotic, and there is no columella. Among salamanders in general the columella is functional during larval life, but not during adult life, the operculum developing at metamorphosis and filling the fenestra, while the columella fuses with the periotic, or disappears. The aquatic habits of adults as well as larvae, in the ancestral *Plethodont,* explain the general retention of the columella as a functional part, and all one can say about *Batrachoseps* is that it is one of the most terrestrial genera and has departed as far in habits from the ancestral mode of life as it has departed in otic apparatus.

No particular variations are seen in the quadrate, which is always present.

The squamosal bears high crests in *Gyrinophilus,* and *Pseudotriton,* but in other forms is an undistinguished flat bone.

There is never a developed bony pterygoid.

Orbitosphenoids are always present.

The tongue is primitively attached by a central pedicel, by a strip from this anteriorly to the front of the tongue and by the front edge of the tongue. This is the condition in *Chioglossa,* a Salamandrid, and in the forms of the *Desmognathus* and *Plethodon* groups. In *Stereochilus* and in *Typhlotriton* the attachment anterior to the pedicel is weaker, and in the *Eurycea* group it is absent and the tongue can be entirely projected from the mouth, in some cases as far as half the length of the body.

The hyo-branchial apparatus of the adult consists of a pair of hyoid cartilages; a basal piece with a single pair of cornua; a tiny otoglossal (in *Eurycea bislineata bislineata,* Smith 1920); two ceratobranchials; and a single epibranchial. There is a singular uniformity in the apparatus throughout the family, save that two genera of the free-tongued group, *Hydromantes* and *Oedipus,* have the epibranchial unusually long.

The larva has an apparatus consisting of a pair of hyoids; two basal pieces (of which the posterior loses its connection with the rest at transformation and becomes the os thyreoidum); two ceratobranchials; and three or four epibranchials, of which all but the most anterior disappear at transformation. Larval *Desmognathus* have 4 epibranchials; apparently most of the other larvae have 3.

The vertebrae are essentially similar throughout the family save for the atlas and the tail vertebrae. They are like those of *Ambystomidae*

and *Salamandridae*. The tail vertebrae of the more aquatic forms have haemal and neural spines in the form of flattened plates, which are absent in the terrestrial forms. When the tail is constricted at the base for autotomy the break occurs between two vertebrae.

The vertebrae may be either amphicoelous or opisthocoelous, depending on whether the intervertebral cartilage, which is functionally part of the vertebra posterior to it, ossifies or not. This is largely a matter of age, some forms becoming opisthocoelous at transformation and others at old age. Some apparently remain amphicoelous throughout life. The character has obviously little or no systematic importance in this particular group.

The atlas has usually a longitudinal dorsal ridge, and a more or less double process on the ventral side which fits between the condyles. In *Desmognathus* and *Leurognathus* there is a high transverse ridge on the dorsal side for the attachment of a strong tendinous slip of the temporalis muscle, and the "odontoid" process is reduced almost to the point of absence.

The ribs are like those of *Salamandridae* and *Ambystomidae* and are forked distally.

The position of the ribs is marked externally by the costal grooves. These range in number from 12 in the aquatic forms to 21 in the burrowing, worm-like forms. The most usual number is 14.

The tail is more or less flattened in the aquatic forms and keeled or finned above. In terrestrial forms it is terete, and in *Oedipus, Hemidactylium* and *Ensatina* there is a groove at the base of the tail marking the point where autotomy takes place. The tail is longer in adults than in young, and longer in adult females than in adult males.

The body muscles resemble those of *Salamandra* and of *Chioglossa*, but are in general better developed. There is a great difference between the body muscles of *Triturus*, which walks high off the ground, and holds its body stiff, and those of a *Plethodont* which wriggles like a snake. And only the *Plethodontidae* have developed elongate, snake-like, forms.

In the adult there are present *obliquus externus superficialis, obliquus externus profundus, transversus, rectus abdominis superficialis*, and *rectus abdominis profundus*. In the larva the *obliquus* and *transversus* are present but the two *rectus* separate from the more dorsal muscles at transformation. There is no *obliquus internus*

in either larva or adult. In *Salamandra* this muscle is present in the larva, but fuses with *transversus* in the adult. The adult *Chioglossa* has the same muscles as *Salamandra*. Adult and larval *Triturus* and *Ambystoma* have all three *obliquus* and a *transversus*. The *rectus abdominis superficialis* splits off in both genera at transformation, but *the rectus abdominis profundus* never splits off from the *obliquus externus profundus* and the *obliquus internus*.

The muscles are similar throughout the family save that the atlas slip of the *Temporalis* is tendinous in *Desmognathus* and *Leurognathus*. Thus the lower jaw is immovably attached to the atlas, and the mouth is opened by raising the skull. The function of this arrangement, with which is connected the stalked condyles, and collared atlas of these forms, is to prevent the downward bending of the head, and to stiffen the anterior part of the body.

The thigh muscles are those of the *Salamandroidea*, and the *pubotibialis* is distinct from the *puboischiotibialis*.

The legs are rather weak in the burrowing forms.

The carpus in *Plethodon, Eurycea,* and *Pseudotriton* is generally similar. Using the modern nomenclature, and comparing it with *Hynobius* and *Ambystoma,* the 8 elements are: radiale, mediale 1 of the preaxial portion; ulnare, intermedium-centrale, mediale 2 and 3, carpale 1 and 2, carpale 3, carpale 4, of the postaxial portion. The phalangeal formula in *Aneides, Plethodon, Ensatina, Desmognathus, Stereochilus, Gyrinophilus, Pseudotriton* and *Eurycea* is 1, 2, 3, 2.

The tarsus in the five-toed forms similarly consists of 9 elements, which seem to be: tibiale, mediale 1 in the preaxial part; fibulare, intermedium and centrale, mediale 2 and 3, tarsale 1 and 2, tarsale 3, trasale 4, tarsale 5 in the postaxial part. This is based on *Desmognathus, Plethodon, Hydromantes, Pseudotriton,* and *Eurycea.* In the four-toed *Hemidactylium* tarsale 5 seems to be missing.

The carpus and tarsus are normally cartilaginous. *O. pennatulus* has these elements bony. This seems to be unimportant from a systematic standpoint, *Hynobius* displaying great variation in this respect, and I have seen a stained and cleared specimen of *Plethodon glutinosus* in which these elements were ossified.

The phalangeal formula, based on the same genera as that for the hand, is normally 1, 2, 3, 3, 2. In the four-toed species one would expect to find it 1, 2, 3, 3. There seems to be a certain amount of varia-

tion, for in a single stained and cleared specimen of *Desmognathus fuscus fuscus* I find on one foot the normal formula and on the other 1, 2, 4, 3, 2. In a similarly treated specimen of *Gyrinophilus porphyriticus* I find the normal formula on one foot and on the other 1, 3, 3, 3, 2.

Forms with much reduced feet might be expected to show some reduction from these carpal and tarsal and phalangeal formulae but the normal state of affairs is represented by the list above which is the combined work of Cope (1889), Steiner (1821) and myself.

Primitively fingers and toes are free. In various terrestrial forms the feet and hands are more or less completely webbed. This reaches its maximum development in *Oedipus*.

The legs are proportionately longer in young specimens, and in adult males than in adult females.

In all primitive forms there is a groove running horizontally from the eye along the sides of the head to meet an upward extension of the gular fold, and a groove vertically down from this behind the angle of the jaw. One or both of these are lost in specialized species.

The eyelids ordinarily fit under a fold of skin behind. In various large-eyed species, especially in *Eurycea*, this fold fuses with the lower eyelid so that the upper appears to fit posteriorly into a slit in the lower.

Proportions are quite variable both individually and with age. Yet they make up the majority of the habit characters or "Habituëllen-Merkmalen," which come to be a reliance with growing familiarity with the group. "This general look of things . . . which is the unconscious summing up of a great many details," says Admiral Knight, apropos of the steering of battleships in formation, is extraordinarily hard to put on paper. Yet it is unquestionably a specific or even a generic character. All the species of *Desmognathus* look alike, but it is futile to try to write a description of a *Desmognathus* worth half as much as a good look at a live animal. I have seen a child who could not read and who had never seen the animals before, sort out a collection of *Desmognathus* with accuracy on being told to "see how many kinds you can find in the lot." Of course, these were fresh specimens, yet the habit characters were the child's guidance as he could see no others. And as the habit characters show to greater advantage in

fresh specimens, they show still better in live animals, when there are added the equally characteristic movements and postures.

The vent is a longitudinal slit in both sexes. The edges are better developed in males than in females, and in males the inner walls are lined with closely set papillae. This affords an excellent means of distinguising between the sexes, the walls of the female vent being smooth or folded, but not papillate.

In *Desmognathus* the male is much larger than the female. In the other groups, when there is discrepancy in size, the female is the larger.

In *Desmognathus* the jaws of the male are sinuous in outline and the lower jaw has a prominent glandular projection at the chin.

In the other groups when there is any sexual dimorphism the snout of the male is swollen. This swelling is especially in the region of the nostrils and the naso-labial groove, and frequently results in a tubercle appearing below the nostril, and in some species of *Eurycea* this tubercle elongates into a cirrus, with the naso-labial groove on its outer face.

In *Hydromantes* and most *Oedipus* the young have extremely large nostrils, not only relatively but actually larger than those of the adults. Possibly this is in some way connected with the fact that these genera have live young. In certain small *Oedipus* the large nostrils are retained throughout life.

The gills of the aquatic larvae are of the usual external type, long rami projecting from the septa, and filaments or fimbriae hanging from the ventral edge of each ramus. They are of this type in *Hemidactylium*, *Stereochilus*, *Typhlotriton*, *Typhlomolge*, and the *Eurycea* group. In the *Desmognathus* group, the rami are lacking and the fimbriae arise directly from the septa. This situation is paralleled in the *Hynobiidae* and in the *Ambystomidae*, in which families *Batrachuperus*, *Onychodactylus*, *Dicamptodon*, and *Rhyacotriton* are known to have gills of the *Desmognathus* type, and the last three of these genera are known to inhabit streams with rapid current, while the genera of these two families with normal gills inhabit still water. But here the analogy falls to the ground, for no one would assert that *Desmognathus* larvae lived in more rapid water than *Gyrinophilus* larvae.

The forms that transform in the egg have, in the case of *Plethodon cinereus* the usual type of gill but weakly developed. *Batrachoseps*

attenuatus attenuatus has simply three rami with no fimbriae, and the blood stream does not break up into capillaries in the gills. *Aneides lugubris* has three broad, flattened, leaf-like rami, which are highly vascular and functional and merit the name of allantoic gills nearly as well as the gills of embryonic *Gastrotheca*.

The larva has a fin on both dorsal and ventral edges of the tail. This is the usual state of affairs in mountain brook forms, and serves in various families of salamanders to distinguish larvae which live in current from those which live in still water and have a dorsal fin on the body as well. Even tadpoles of various species of *Hyla* and *Phyllobates* show these differences. The larva of *Hemidactylium* alone has a dorsal fin on the body.

The absence of lungs and ypsiloid apparatus is universal in the family. There is some indication of the presence of rudimentary vestiges of ypsiloid muscles. In connection with lung degeneration is the abortion of the left auricle and the spiral valve of the conus. (See Noble 1925, Journ. Morph. 40, p. 34). Respiration in these forms is carried on through the skin, and through the walls of the pharynx and throat (bucco-pharyngeal). The groove from the nostril to the lip, found throughout the family and confined to them, is an additional mechanism for bucco-pharyngeal respiration, serving to drain the nostril of water when the animal emerges. In correlation with lung reduction it has been recently shown by Emmel that the *Plethodontidae* have a higher percentage of non-nucleated erythrocytes than other salamanders, and this percentage is very high (95%) in *Batrachoseps,* where integumental respiration is ill-developed, and where gill respiration in the larva is non-existent.

This family practices internal fertilization, and the female has a spermatheca in the form of a median sac, a distinct advance over the series of tubules which serve as a spermatheca in other families of Salamandroids. (See Koehring 1925 on *Eurycea bislineata*).

The oviducts of the species of *Hydromantes* and *Oedipus* have much thicker walls than those of the other genera, in correlation with the fact that they give birth to live young.

The chromosome numbers of a few members of the family are known and are here set down: *Desmognathus fuscus,* diploid number 24, haploid 12 in the males (Kingsbury 1899, 1902, Montgomery 1903); *Plethodon cinereus,* diploid 24, haploid 12 in the male (Montgomery 1903); *Batrachoseps attenuatus,* diploid 24, haploid 12 in the

male (Eisen 1900, Jannsens and Dumez 1903); *Aneides lugubris,* diploid 28, haploid 14 in the male (Snook and Long 1914); *Hydromantes italicus,* diploid 24, haploid 12 in the male (Terni 1910, 1911, 1914).

The color pattern of the mountain-brook forms is based largely on the development of three rows of unpigmented areas on each side of the larva, a dorsal set, a lateral set, and a ventro-lateral set, the last running from arm to leg. These unpigmented areas, as shown by Banta and McAtee (1906) for *Eurycea lucifuga* attract black pigment cells. With transformation a general pigmentation of either red or yellow appears in places where the black pigment is absent.

The history of the color pattern in various forms is the history of the varying development and fate of these unpigmented areas and their relative success in attracting pigment.

The dorsal areas are always the most important. They may form in the adult a double series of discrete light spots; a double series of light spots partially coalesced with others of the same series and across the mid-dorsal line with spots of the opposite series; a dorsal band whose crenulate edges give evidence of the position of spots no longer existent as such; or a complete dorsal band whose straight edges give no evidence of former spots.

This process is gone through in its entirety by every individual of *Desmognathus fuscus fuscus* or *Eurycea bislineata bislineata,* so that a description of the color pattern of either of these species is practically a description of nearly every form of pattern found in the entire family and no easy matter. Fortunately the adult and permanent pattern is fairly definitive for different species, which stop at one stage or another in the general scheme outlined above.

The black pigment of the middle of the back, caught between the two coalescing rows of light areas, may disappear entirely, may persist as spots of dark in a light dorsal band, or may fuse into a mid-dorsal dark streak.

The lateral areas may disappear entirely, may persist as small light spots on the dark sides, may attract rings of dark pigment, or may form a light lateral stripe.

The ventral areas usually disappear, may persist as small light spots, and in a few forms may fuse into a light streak at the edge of the belly. Their usual insignificance is due to the paucity of black pigment in this region.

In *Eurycea lucifuga* the light dorsal band forms as described above and then the pattern breaks up into irregularly arranged black spots which give no indication of there ever having been any pattern.

This adult result is much like that of *Pseudotriton*, but in that genus and in *Gyrinophilus* and *Desmognathus quadra-maculatus* as well the cause is very different for in them the larval areas do not attract pigment at all but remain small, and have no effect on the color pattern.

In many species and individuals general darkening of the whole dorsal surface may obscure the pattern entirely. This is usually an affair of age, many forms becoming old and black.

In the forms which have no larvae the frequent presence of paired dorsal spots or of a light dorsal band is strongly reminiscent of the pattern produced by the dorsal areas of the more aquatic forms, and, as alignment of species on other characters leads to the same arrangement, one can grade these forms as primitive or specialized with regard to color pattern in the same order as the aquatic forms, light spots, crenulate dorsal band, straight dorsal band, no light dorsal markings.

Loss of dorsal color pattern may take various forms and in *Plethodon* is especially instructive.

P. yonahlossee has large paired red dorsal areas in the young. In the adult these are invaded by black pigment and disappear but the red is visible as a dull dorsal band.

P. wehrlei may or may not have tiny paired red spots on the back, and occasionally young *P. glutinosus* has the same marking.

P. dorsalis has a zig-zag dorsal band, which in some old individuals disappears because of the darkening of the dorsal region and lightening of the sides perhaps on account of an actual migration of black pigment from sides to dorsum.

P. cinereus has a striped phase in which there is a straight dorsal band, and a dark phase in which the sides and dorsum are black. The two phases are distinct from birth and are probably allelomorphic characters, never turning one into the other, and pure lines of one or of the other being met in some localities.

In *Aneides*, many *Plethodon*, *Hydromantes*, and many *Oedipus* no trace of the primitive pattern can be seen.

In many forms there is a third pigment, white. This is quite dif-

ferent from the white caused by lack of pigment. It is seen most conspicuously in *P. glutinosus*.

MATERIAL

Inasmuch as the value of a systematic revision of a group of animals is directly related to the number of specimens seen, and to the amount of field experience with the various forms, I have thought it well to append a list showing for the species the number of specimens seen and the number of specimens collected by me; and for the genera a list showing the number of species, the number of species seen, the number of specimens seen, the number of species collected by me, and the number of specimens collected by me.

The numbers, especially in the case of the common eastern species, are underestimates.

I have examined over 12,600 specimens representing all the genera and all but one of the species, collected over 2,300 specimens, and have had field experience with 8 of the 15 genera, and with 34 of the 86 forms.

The most recent complete revision of the group, that of Boulenger in 1882, was based on less than 200 specimens, representing 11 genera and 28 forms.

I have also examined a number of skulls of various species of the group as follows:

Desmognathus fuscus, D. quadra-maculatus, Leurognathus marmorata, Plethodon yonahlossee, P. glutinosus, P. metcalfi, P. vandykei, P. cinereus, Hemidactylium scutatum, Ensatina eschscholtzii, Aneides aeneus, A. lugubris, Batrachoseps attenuatus, B. pacificus, Stereochilus marginatum, Typhlotriton spelaeus, Typhlomolge rathbuni, Gyrinophilus porphyriticus, G. danielsi, Pseudotriton ruber, P. montanus, Eurycea bislineata, E. longicauda, E. gutto-lineata, E. quadridigitata, E. lucifuga, Hydromantes genei, H. platycephalus, Oedipus bellii, O. robustus, O. chiropterus, O. cephalicus, O. subpalmatus, O. adspersus, O. platydactylus, O. salvinii, O. striatulus, O. uniformis, and *O. alfaroi.*

The material examined has been very uneven. The 30 species of *Oedipus* are represented in my material by 588 specimens; the 7 species of *Desmognathus* by over 5,000.

A geographical arrangement will make the defects apparent. Eu-

rope has to her credit 3 names. I have seen 17 specimens and no types.

The region from Mexico southwards has 54 names. I have seen 588 specimens and 17 types. These are the extant types of the 24 names by Americans. Of the 22 Continental names, the 7 British names, and the single South American name I have seen no types.

From the United States and Canada 96 names are applicable. I have seen over 12,000 specimens and 40 types.

It is of course obvious that the *Oedipus* are very ill represented. I am, however, confident that I have seen a much greater material of this genus than any previous worker, and I have seen 12 of the thirty species in the field. (The first column is the number of specimens seen; the second the number seen in the field).

Desmognathus quadra-maculatus	304	158
phoca	434	176
fuscus fuscus	3165	358
auriculatus	100	0
brimleycrum	103	0
carolinensis	436	291
ochrophaeus	605	0
Leurognathus marmorata	35	1
Plethodon yonahlossee	44	37
wehrlei	17	0
glutinosus	774	137
jordani	38	37
shermani	3	0
metcalfi	331	272
vandykei	28	0
intermedius	22	0
elongatus	2	0
dorsalis	62	0
cinereus	1258	210
Ensatina platensis	0	0
croceater	12	0
eschscholtzii	89	0
Hemidactylium scutatum	103	23
Aneides aeneus	10	0
ferreus	24	0
lugubris	239	0
flavipunctatus	23	0
Batrachoseps attenuatus attenuatus	394	0
caudatus	3	0
pacificus	52	0
major	36	0

catalinae	5	0
leucopus	18	0
Stereochilus marginatum	16	0
Typhlotriton spelaeus	87	0
Typhlomolge rathbuni	45	0
Gyrinophilus porphyriticus	139	14
danielsi	40	13
Pseudotriton ruber ruber	735	115
nitidus	15	3
schencki	76	28
montanus montanus	158	5
flavissimus	15	0
Eurycea bislineata bislineata	953	167
wilderae	132	70
cirrigera	135	52
multiplicata	43	0
melanopleura	62	0
longicauda	144	10
gutto-lineata	139	39
quadridigitata quadridigitata	101	0
remifera	55	0
lucifuga	148	0
Hydromantes italicus	16	0
genei	1	0
platycephalus	2	0
Oedipus bellii	50	4
schmidti	1	0
robustus	16	10
sulcatus	2	0
chiropterus	49	32
rex	11	0
townsendi	7	5
pennatulus	8	0
nasalis	19	0
picadoi	7	0
cephalicus	52	18
rostratus	5	0
morio	19	0
subpalmatus	48	29
adspersus	126	0
altamazonicus	4	0
platycephalus	43	4
salvinii	3	0
attitlanensis	2	0
lignicolor	12	0
yucatanus	3	0

striatulus	6	0
rufescens	20	0
colonneus	2	1
lineolus	3	0
complex	6	0
uniformis	36	23
collaris	2	1
parvipes	23	4
alfaroi	3	3

A = number of forms in genus; B = number of forms examined; C = number of specimens examined; D = number of forms seen in the field; E = number of specimens seen in the field.

	A	B	C	D	E
Desmognathus	7	7	5147	4	983
Leurognathus	1	1	35	1	1
Plethodon	11	11	2579	5	693
Ensatina	3	2	101	0	0
Hemidactylium	1	1	103	1	23
Aneides	4	4	296	0	0
Batrachoseps	6	6	508	0	0
Stereochilus	1	1	16	0	0
Typhlotriton	1	1	87	0	0
Typhlomolge	1	1	45	0	0
Gyrinophilus	2	2	179	2	27
Pseudotriton	5	5	999	4	151
Eurycea	10	10	1911	5	338
Hydromantes	3	3	19	0	0
Oedipus	30	30	588	12	134
Total	86	85	12614	34	2350
	A	B	C	D	E

There are 15 genera, 71 full species, and 86 forms or races.

REMARKS

I have included in this paper what seem to me to be the essentials of a systematic treatise. These are: descriptions of the various forms in the group; descriptions of their ranges; accounts of their habits; statements of their relationship to each other and of the whole group to other groups; an account of their probable origin and dispersal; an account of the previous work on the group; the names by which the various forms have been known, and references to the papers containing information about them; lists of the specimens seen and references to the collections in which they are preserved; lists of the

localities from which the various forms have been recorded; and an account of the anatomical characters which distinguish the forms and the higher groups.

The nomenclature adopted is in strict accordance with the International Code. I have considered the gender of generic names as fixed by the describer of the genus, as this seems to be the spirit of the Code although no rule states as much. Parentheses have been used where the name is not exactly as originally proposed.

The references are unquestionably incomplete, in spite of all attempts at completeness. I have intentionally omitted many merely nominal references, but made great efforts to include all references which contain any information concerning an animal.

I have kept even variant spellings of a name in individual groups, but placed those groups together as against an obviously different name.

Where special information concerning a modern species is found in an early work under an early name I have placed the reference in the synonymy of the modern form. I have not felt obligated to do so unless special information is so to be found.

The synonymies of the genera and the family contain only one reference to each name.

All measurements are in millimeters. The head length is from tip of snout to gular fold on the ventral surface; the body length is from gular fold to posterior angle of vent; the tail length is from posterior angle of vent to tip of tail. I have tried to give the measurements of the largest and smallest of each sex and stage.

In the lists of specimens numbers referring to larvae are in italics.

The method of stating the ranges is to give points at the periphery of the range. For forms occurring in the United States I have given the Physiographic Regions in which they are found. These express the ranges of these creatures better than any other method yet devised, although imperfectly. The physiographic regions have also the obvious merit of objective existence. Neither Faunal Zones nor Phytogeographic Regions can be used with any comfort in describing the ranges of these salamanders.

Circles on the maps indicate records, solid dots indicate localities whence I have seen specimens.

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PLETHODONTIDAE GRAY

1850 *Plethodontidae* Gray, Cat. Batr. Grad. Brit. Mus., p. 31 (partim).
1856 *Bolitoglossidae* Hallowell, Proc. Acad. Nat. Sci. Philadelphia, p. 11.
1856 *Hemidactylidae* Hallowell, l. c., p. 11.
1859 *Spelerpinae* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 123.
1866 *Desmognathidae* Cope, Journ. Acad. Nat. Sci. Philadelphia (2), 6, p. 107.
1869 *Thoriidae* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 110.
1882 *Plethodontinae* Boulenger, Cat. Batr. Grad. Brit. Mus. (2), p. 51.
1882 *Desmognathinae* Boulenger, l. c., p. 76.
1917 *Typhlomolgidae* Stejneger and Barbour, Check List, p. 6.

Diagnosis: *Salamandroidea* with naso-labial groove; no lungs; no ypsiloid cartilage; ypsiloid muscles degenerate; no anterior projection of pubis; body muscles lacking obliquus internus; both rectus abdominis muscles developed; no neural ridge on vertebrae; vertebrae either amphicoelous or opisthocoelous; carpus and tarsus either bony or cartilaginous; no bony pterygoid; no posterior prolongation of prevomers; posterior prolongation of prevomers represented by dentigerous plates on parasphenoid; no postfrontosquamosal arch; spermatheca a median sac; otic apparatus composed of columella and operculum fused, operculum attached by narrow isthmus to periotic (ex. *Batrachoseps* where columella absent, operculum free); total length of adults from 42 mm. *(Oedipus townsendi)* to 275 mm. *(Oedipus bellii);* 15 genera; 86 species and subspecies.

Range: Sardinia; northwestern Italy and southeastern France; southern Canada; United States; southern Mexico to Venezuela and Bolivia; Uruguay and Argentina at mouth of Rio de la Plata.

Key to Genera of *Plethodontidae:*

(Adults of the family may usually be recognized by the presence of the naso-labial groove from the nostril to the edge of the upper lip. The parasphenoid tooth patches on the roof of the mouth between the eyesockets are another character whereby they may be easily identified).

A. Blind unpigmented cave forms.
  B. Legs very long and slim, permanent larvae . . *Typhlomolge* 253
  B B. Legs normal, transforming . . . . . *Typhlotriton* 248
A A. Pigmented forms with functional eyes.
  B. Tongue attached in front.

C. Toes 4-4.
D. Belly white with black spots, 14 costal grooves . . . . *Hemidactylium* 196
D D. Belly not white with black spots, more than 14 costal grooves . . . . . *Batrachoseps* 224
C C. Toes 4-5.
D. Head with large pores, vomerine and parasphenoid series continuous . . . . . *Stereochilus* 244
D D. Head without large pores, vomerine and parasphenoid series not continuous.
E. Light line from eye to angle of jaw . . *Desmognathus* 63
E E. No light line from eye to angle of jaw.
F. No vomerine teeth, internal nares inconspicuous, twice as far apart as external nares . *Leurognathus* 120
F F. Vomerine teeth present, internal nares conspicuous, as far apart as external nares.
G. Teeth only in front of mouth, hind part of maxilla knife-edged . . . . . *Aneides* 205
G G. Teeth all along jaws; maxilla normal.
H. Tail constricted at base . . . . *Ensatina* 181
H H. Tail not constricted at base . . *Plethodon* 128
B B. Tongue not attached in front, mushroom shaped.
C. Vomerine and parasphenoid series continuous.
D. A marked canthus rostralis . . . . . *Gyrinophilus* 259
D D. No marked canthus rostralis . . . . *Pseudotriton* 272
C C. Vomerine and parasphenoid series not continuous.
D. Tail not constricted at base.
E. Toes free; tail flattened . . . . . *Eurycea* 294
E E. Toes partly webbed; tail terete . . *Hydromantes* 344
D. Tail constricted at base . . . . . *Oedipus* 355

The general relationships of the genera are briefly as follows:

Desmognathus and *Leurognathus* are forms with a peculiar development of occipital condyles, atlas, and temporal muscles which function to keep the lower jaw immovable. The mouth is opened by lifting the upper jaw and head. The object of this peculiar mechanism is to stiffen the anterior part of the body so that it can be forced under things.

Leurognathus differs in a peculiar shifting of the internal nares, which is apparently a further adaptation to aquatic life.

None of the other genera have the peculiar atlas, condyles, or muscles.

Plethodon has no aquatic stage, but otherwise is not peculiar.

Ensatina differs from *Plethodon* in having a basal constriction of the tail which is a provision for autotomy and a further adaptation to terrestrialism. It also differs in having tubercles on the palm.

Hemidactylium has the basal constriction of the tail, only 4 toes, and an aquatic stage. Otherwise it is like *Plethodon.*

Aneides differs from *Plethodon* in having fused premaxillaries; peculiar dentition and maxillaries; and Y-shaped terminal phalanges. The last seem an adaptation to arboreal life.

Batrachoseps differs in having fused premaxillaries; no prefrontals; 4 toes; and a worm-like shape.

Stereochilus has an aquatic stage; primitive dentition; and fused premaxillaries.

Typhlotriton is somewhat like *Stereochilus,* but is blind and lacks pigment and is a cave dweller.

Typhlomolge is a cave dweller, blind and white, and is a permanent larva.

The remaining genera form a group in which the tongue is free in front.

Gyrinophilus is primitive in most respects.

Pseudotriton differs in having fused premaxillaries.

Eurycea differs from *Pseudotriton* in having the vomerine and parasphenoid series separated.

Hydromantes differs from *Gyrinophilus* in not being aquatic, and in having vomerine and parasphenoid series separate.

Oedipus differs from *Hydromantes* in having fused premaxillaries and in having a basal constriction of the tail.

The theoretically primitive genus should fit the following definition: Tongue attached in front; two premaxillae, nasal spines not fused, a fontanelle; septomaxilla present; maxilla normal; prefrontals present, bordering nares; vomerine and parasphenoid series continuous; condyles sessile; atlas normal; eyes functional; gills of larvae with long rami; 4 epibranchials; no sexual dimorphism; toes 4-5, free;

terminal phalanges T-shaped; tail not constricted at base; no palmar tubercles; mountain brook forms.

To this definition *Gyrinophilus* approaches most closely. There are only three epibranchials in the larval apparatus, and the tongue of the adult is free in front. *Plethodon* differs in dentition, lack of larvae, and habitat; *Stereochilus* in fused premaxillae and in habitat.

Among the *Salamandridae, Chioglossa lusitanica* of the Iberian peninsula is interesting as the closest ally. It is a mountain brook species with reduced lungs. The tongue is like that of *Plethodon* and is less attached than the tongue of any other salamander outside this family. It is not itself ancestral, as the nasal spines of the premaxillae are as reduced as those of the *Hynobiidae,* so that the genus forms an exception to the whole series of *Salamandroidea* in this respect.

Aquatic larvae are known to occur in *Desmognathus, Leurognathus, Hemidactylium, Stereochilus, Typhlotriton, Gyrinophilus, Pseudotriton,* and *Eurycea. Typhlomolge* is a permanent larva. Apparently the species of *Plethodon, Ensatina, Aneides, Batrachoseps, Hydromantes,* and *Oedipus* do not have aquatic larvae.

These may be told from the larvae of *Triturus* and *Ambystoma* which occur in the same region by the general absence of a dorsal fin fold on the body which characterizes mountain brook larvae of all families. The single exception is that of *Hemidactylium scutatum* which lays its eggs out of water, but near rather temporary pools, and represents in some of its habits a return to a more primitive state of affairs. Its larvae have a dorsal fin fold on the body, but it is quite low and the slim form of the creature is sufficient to distinguish it from the stouter and more tadpole-like larvae of *Triturus* and *Ambystoma.*

The larvae I have seen may be told apart by means of the following key:

A. A dorsal fin and a caudal fin; gills with long rami . . . . . *Hemidactylium scutatum* 196

A A. No dorsal fin.

B. Blind, pigmentless, legs very long and slim, 12 costal grooves *Typhlomolge rathbuni* 253

B B. Eyes present, pigmented, legs normal, more than 12 costal grooves.

C. Gills without rami.

D. A definite light dorsal area . . *Desmognathus fuscus* 81

D D. No definite light dorsal area.

E. Eyes smaller, more lateral; chin and throat light; lighter *Desmognathus quadra-maculatus* 63

E E. Eyes larger, more dorsal; chin and throat dark; darker . . . . . *Leurognathus marmorata* 120

C C. Gills with long rami.

D. Back and sides same color.

E. Irregularly streaked on sides *Stereochilus marginatum* 244

E E. Not so marked.

F. Head longer, chin and throat dark . . . . . *Gyrinophilus porphyriticus* 259 and *G. danielsi* 266

F F. Head shorter, chin and throat light.

G. 16 costal grooves.

H. Tail longer than body; not spotted; Missouri and Arkansas . . . *Typhlotriton spelaeus* 248

H H. Tail shorter than body; irregularly spotted; east of Mississippi . . *Pseudotriton ruber* 272

G G. 17-18 costal grooves; spotted with circular dots *Pseudotriton montanus* 286

D D. Back lighter than sides.

E. Toes 5.

F. No sharp demarcation between lighter back and darker sides. Lower row of larval areas present, a gray band on sides, 14-15 costal grooves *E. lucifuga* 338

F F. A sharp and uninterrupted demarcation between the lighter back and the darker sides, lower row present, sides black, 13-14 costal grooves.

G. Lower row a definite stripe . . *E. gutto-lineata* 327

G G. Lower row not a definite stripe . . . . . *E. longicauda* 320 and *melanopleura* 316

F F F. A sharp but broken demarcation between the lighter back and the darker sides, lower row absent.

G. 14-15 costal grooves . . . . . *E. bislineata* 295

G G. 20 costal grooves . . . . *E. multiplicata* 313

E E. Toes 4, lower row a definite stripe *E. quadridigitata* 331

While this key will work in the majority of cases, it is well to pay attention to the geographical probability and to the fact that as a general rule the larvae of *E. bislineata* and its races are more frequently met with than larvae of all the rest put together.

DESMOGNATHUS BAIRD

1850 *Desmognathus* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 282 (type *fuscus*).

Diagnosis: Tongue attached in front; one premaxilla, nasal spines fused, a fontanelle; septomaxilla present; maxilla normal; no prefrontals; internal naris a notch in prevomer; vomerine and parasphenoid series not continuous; condyles stalked; atlas with transverse collar; eyes functional; gills of larva without rami; four epibranchials; adult males of some species larger than females, with mandibles edentulous on posterior part, lacking vomerine teeth, with enlarged teeth on premaxilla; tail not constricted at base; toes 4-5, free; terminal phalanges T-shaped; no palmar tubercles; seven forms.

Range: New Brunswick to Florida, Texas and Illinois. Manitoba.

Key to adults of *Desmognathus:*

A. Tail not keeled, terete; small species.
  B B. A tubercle in anterior angle of eye, belly dark, southern mountains . . . . . *ochrophaeus* 114
  B. No tubercle in anterior angle of eye, belly light, northern mountains . . . . . *carolinensis* 105
A A. Tail keeled above, trigonal; medium and large forms.
  B. Belly uniformly pigmented.
    C. Belly black; tail short; large and stout *quadra-maculatus* 63
    C C. Belly light; tail long; slim . . . . . *phoca* 73
  B B. Belly mottled.
    C. No row of light spots on sides . . . . . *fuscus* 81
    C C. A row of light spots on sides.
      D. Belly dark; southeastern . . . . . *auriculatus* 97
      D D. Belly light; Arkansas and Texas . . *brimleyorum* 101

DESMOGNATHUS QUADRA-MACULATUS (HOLBROOK)

1840 *Salamandra maculo-quadrata* Holbrook, N. Amer. Herp. 4, p. 121.
1840 *Salamandra quadra-maculata* Holbrook, l. c., pl. 28.
1923 *Desmognathus quadra-maculata*, Breder and Breder, Zoologica 4, 1, p. 17.
1917 *Desmognathus quadra-maculatus* Stejneger and Barbour, Check List, p. 23; Dunn 1920, Proc. Biol. Soc. Washington 33, p. 132; Stejneger and Barbour 1923, Check List (2), p. 20; Bishop 1924, Bull. New York Mus. 253, p. 93; 1925, Copeia 139, p. 11; Noble 1925, Journ. Morph. 40, p. 373, f. 18 (skin).

1917 *Desmognathus quadramaculata* Dunn, Proc. U. S. Nat. Mus. 53, p. 401; 1917, Bull. Amer. Mus. Nat. Hist. 37, p. 607, pl. 58, ff. 1-2, pl. 59, f. 1.
1924 *Desmognathus quadramaculatus* Pope, Amer. Mus. Nov. 153, p. 8 (habits).
1842 *Salamandra quadrimaculata* Holbrook, N. Amer. Herp. (2), 5, p. 49, pl. 13.
1854 *Ambystoma quadrimaculatus* Duméril and Bibron, Erp. Gén. 9, p. 109.
1856 *Plethodon quadrimaculatus?* Hallowell, Proc. Acad. Nat. Sci. Philadelphia, p. 11.
1903 *Desmognathus quadrimaculata* Stejneger, Proc. U. S. Nat. Mus. 26, p. 557; Fowler and Dunn, Proc. Acad. Nat. Sci. Philadelphia, p. 22.
1907 *Desmognathus quadrimaculatus* Brimley, Bull. Elisha Mitchell Sci. Soc. 23, 4, p. 154; 1912, Proc. Biol. Soc. Washington 25, p. 137.
1842 *Triton niger* Holbrook, N. Amer. Herp. (2), 5, p. 81, pl. 27.
1849 *Desmognathus niger* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 285; Gray 1850, Cat. Batr. Grad. Brit. Mus., p. 40; Boulenger 1882, id. (2), p. 79.
1854 *Ambystoma nigrum* Duméril and Bibron, Erp. Gén. 9, p. 105.
1869 *Desmognathus nigra* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 113; 1888. Journ. Morph. 2, pl. 23, f. 1 (otic region); 1889, Bull. U. S. Nat. Mus. 34, p. 198, f. 50, pl. 49, f. 1; Rhoads 1895, Proc. Acad. Nat. Sci. Philadelphia, p. 400; Moore 1899, Proc. Acad. Nat. Sci. Philadelphia, p. 322 (lunglessness); 1900, Proc. Acad. Nat. Sci. Philadelphia, p. 620 (vertebrae); Stone 1906, Amer. Nat. 40, p. 162.

Type: Not known to exist.

Type locality: The Carolinas.

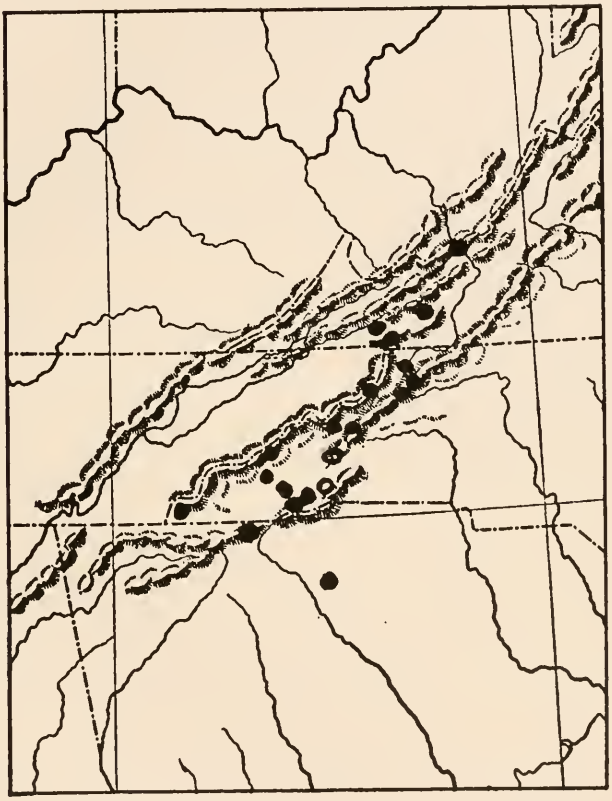
Range: From Wytheville and Giles Co. Va., south in the mountains to Georgia. Blue Ridge, southern section; highest part of Appalachian Valley.

Diagnosis: A *Desmognathus* with vomerine teeth present in adult males; tail keeled above; belly uniform, dark.

Description: Adult male in my own collection; Grandfather Mt., N. C., 13 costal grooves; 2 costal folds between appressed toes; head width 5 in length from snout to vent; head length 3 in length of body; head oval, rugose above; eye shorter than its distance from tip of snout; outline of upper jaw sinuous; angle of jaw back of hind angle of eye; eyelids both fitting under a fold of skin behind; a groove cutting off anterior corner of upper lid; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 3, 4, 5, 2, 1 in order of length; vent papillate; tail shorter than body, flattened and keeled at base, finned above distally; vomerine teeth 3 or 4 in series; parasphenoids in two patches beginning at middle of eyesocket; maxillary and mandibular teeth pointed; premaxillary teeth slightly enlarged; dull

brownish black; head brown; throat, and soles of feet, light; total length 121, head 18, body 54, tail 49.

Variation: A female from Heywood Gap, N. C., in my own collection, differs as follows: 12 costal grooves; 2 costal folds between appressed toes; no papillae in vent; vomerine teeth 8-9 in series, beginning behind inner edge of nares, separated from fellow by width of nares and from parasphenoids by twice that distance; latter in two patches confluent anteriorly, beginning at middle of eyesocket; black, head brown, throat lighter; total length 104, head 17, body 52, tail 35.



2. Southern mountains, showing localities for Desmognathus quadra-maculatus.

A young specimen from Sunburst, N. C., in my own collection, has the vomerines series confluent with its fellow, and separated from the parasphenoids by three times the width of the nares; keel of tail light; a trace of a dorso-lateral series of light spots; total length 94, head 11, body 38, tail 45.

The larva is almost uniform brownish above and uncolored below. They range in length up to 79 mm. Transformed specimens have been seen as small as 49 and as large as 164 mm.

The young are at first like the larvae in color, but the dorsal color becomes gradually darker until it is black in old specimens. The belly, white in the young, soon begins to blacken in an area laterally very definitely defined by a line between arm and leg. Medium-sized specimens have the back dark, the sides light, and the belly dark. The dorsal surface is never lighter than the sides as it is in all the other forms of the genus.

The teeth are sharp, not blunt as in the other species. The testes are unpigmented. Females seem to be sexually mature at a length of 107 mm., head and body 57.

Measurements of a series follow: (V. T. = vomerine teeth; C. F. = costal folds between appressed toes).

Specimen	*Sex*	*Length*	*Head*	*Body*	*Tail*	*V. T.*	*C. F.*	*Locality*
U. S. N. M. 3923	Male	151	.....	*100	50	.....	.....	Abbeville, S. C.
U. S. N. M. 3923	do	157	22	60	75	.....	.....	Do.
U. S. N. M. 14419	do	112	17	61	44	6-6	2½	Wytheville, Va.
U. of Pa.	do	135	20	60	49	3-3	2½	Blowing Rock, N. C.
E. R. D.	do	129	17	55	57	4-3	2	Haywood Co., N. C.
Do	do	121	17	54	49	8-8	2	Do.
A. N. S. 923	do	115	15	56	44	7-7	2½	Giles Co., Va.
A. N. S. 917	do	129	18.5	54.5	56	3-3	2½	Do.
A. N. S. 918	do	119	16	54	49	7-7	2½	Do.
E. R. D.	do	122	17	54	51	3-3	2	Grandfather Mt., N. C.
A. N. S. 916	do	119	16	50.5	49	7-7	2½	Giles Co., Va.
A. N. S. 919	do	105	16	44	45	5-4	.....	Do.
E. R. D.	do	94	11	38	45	5-5	2½	Haywood Co., N. C.
U. S. N. M. 30901	Female	133	18.5	58.5	56	.....	.....	Linville, N. C.
U. of Pa.	do	129	17	57	55	.....	.....	Blowing Rock, N. C.
E. R. D.	do	104	16	53	35	6-8	2½	Haywood Co., N. C.
A. N. S. 920	do	115	15	49	51	6-6	3	Giles Co., Va.
E. R. D.	do	92	14.5	45.5	32	6-4	2	Haywood Co., N. C.
A. N. S. 921	do	73	13	37	23	5-5	3	Giles Co., Va.
A. N. S. 922	do	81	11.5	34.5	35	.....	2½	Do.
A. N. S. 925	do	78	11.5	29.5	37	4-4	3	Do.
A. N. S. 915	.....	125	18	56	51	3-3	3	Henderson Co., N. C.
A. N. S. 913	.....	92	14	43	35	3-4	3	Do.
U. S. N. M.	.....	69	9	31	29	.....	3	Brevard, N. C.
U. S. N. M.	Larva	65	9	28	37	.....	3	Do.

* = head and body.

Habits: Much the most aquatic species in the genus. The Linville river is in places over six feet deep and twenty wide, and these salamanders were seen swimming in the open water of these large pools. They come out of the water frequently, however, and I well remember going down the bed of a stream near Brevard, and how these big, black salamanders ran down the sloping banks into the water, or dropped off the rhododendron branches above our heads, like so many water snakes, as we went by.

I quote the following from Pope (1924) who was fortunate enough to observe the breeding habits.

"At Flat Rock this large salamander was abundant in all the rocky, mountain and hill streams. Stony spring streams, cascading down steep, wooded hillsides, seemed to be their favorite haunts. In Argyle Woods, up on a low mountain, a spring rises. Its small stream flows for less than a quarter of a mile down through a thick jumble of decaying leaves, sections of logs, and small, flat stones. A steep, wooded acclivity rises on either side. In this stream the black salamanders swarmed. The largest specimens seen were taken here. *D. quadramaculatus* is slippery and agile and, in such a difficult place, especially hard to catch. In spite of this, the author, hunting alone, secured more than fifteen specimens in two hours. Here one could walk but a few steps in the stream bed without seeing a specimen dart into the leaves, among the stones, or under a log.

"On July thirteenth the author was working up the bed of this stream with Mr. Alexander King. Mr. King turned over a small stone which was resting in such a manner on a loose mass of leaves and smaller stones that a vacant space was left beneath. Attached to this stone was a cluster of thirty-eight eggs. A large *quadramaculatus*, which was also under the stone, began to dash about confusedly, obviously reluctant to leave the spot. The actions of this individual were in strong contrast to the usual behavior. It was easily caught. The stone was three feet from, and slightly above, the actual flow of the stream but the looseness of the surrounding leaves and stones would have afforded a larva ample opportunity to work its way down to water. The periphery of the under surface of the stone was in complete contact with the leaves and stones on which it rested. The embryos were in an advanced stage, being well pigmented.

"July eighteenth on the old Glenroy estate, Flat Rock, in a brook

which flows through a gently-sloping, open meadow after descending a wooded, rocky hill, a cluster of thirty-one eggs was found in a shallow concavity of the under-side of an irregularly-shaped stone measuring roughly 2 x 8 x 3 inches. The bed of the brook was rocky and the stone found in the meadow was one of many jammed together at a slight 'drop' in the bed. The water flowed swiftly down over the stones and the eggs were probably not actually in the water. The guarding adult did not make off but stayed to bite viciously the hand that picked it up.

"On July seventeenth a small, exceedingly rocky brook which cascades down a steep wooded mountain of the Pisgah National Forests was searched by the author. This brook flows into Looking-glass Creek from the northeast about a mile above Looking-glass Falls. *D. phoca* and *quadramaculatus* were abundant, the latter much smaller than those found in Argyle Woods, Flat Rock. Under a stone (about a foot long and ten inches wide) jammed deep in the mass of stones down over and through which the brook poured, was a cluster of twenty-nine eggs, all with embryos well developed, though entirely unpigmented. In the same lot of stones an adult female *quadramaculatus* was taken. Examination shows that this female had recently laid. This brook is not large and the rocks were many, so probably these eggs were not submerged even though well surrounded by flowing water.

"We worked in Wilson Creek August fifth. This stream crosses the road from Linville to Blowing Rock at a point about fifteen miles from the former (4,100 feet altitude). Working below the road just above the first high falls in the stream, we found *quadramaculatus* to be extremely abundant both in the water and under stones along the water's edge. Wilson Creek has a greater flow than any of the Flat Rock streams hunted. The bed of this small mountain torrent is one jumbled mass of boulders and rocks of all sizes. Its rapid descent is made down cascades and over high falls.

"In four hours we found the following:

(a.) Cluster of 30 eggs on under-surface of a cylindrical stone a foot long and 5 in. in diameter. The stone was jammed in a tiny waterfall. Eggs well developed, but unpigmented.

(b.) Cluster of 32 eggs on under-surface of a small flat stone 8 in.

long. Eggs in one layer, and faintly pigmented. Stone well submerged in a small 'drop' in the stream over which the water rushed.

(c.) Cluster of 15 eggs attached in three irregular groups on the edge of a stone (approximately 15 x 12 x 3 in.). This cluster was found deep in the 'drop' and must have been in the water. The scattered arrangement and small number indicate that some eggs were missing. They were found in exceedingly swift water and many had probably been washed away.

(d.) Cluster of 3 eggs on under-surface of a stone about 6 x 4 x 2 in.

(e.) Cluster of 2 eggs on under-surface of an irregularly-shaped stone 18 in. long.

(f.) Cluster of 39 eggs on under-surface of a cylindrical stone 2 feet long and approximately 6 in. in diameter. The stone was deep in a three foot 'drop.' Eggs in one layer and barely pigmented.

"Of these, *a, b, c,* and *f* are distinct lots, all but *c* complete; *e,* probably the remains of a cluster, had but the two eggs and was far from the other clusters; *b, c,* and *d* were found near one another. The volume and swiftness of the flow were probably responsible for our failing to secure any adults that might have been associated with the eggs. All the clusters were either in or under rushing water; and under such conditions, without the use of big nets, it would be almost impossible to secure adults. Even then, one could not be positive as to the identity of specimens taken. In this respect work done here in the mountain creeks could not be as satisfactory as work in the hills of the lower country. It is interesting to speculate on the possibility of brooding in these higher altitude salamanders. We hunted not more than two hundred yards of stream during the afternoon on which the six clusters were discovered.

"On August sixth we worked in Boone Fork at a point about ten miles from Blowing Rock. The stream flows in its bed of boulders, stones, pebbles, and sand. Its gradual descent at this point is in strong contrast to the cascades and falls of Wilson Creek. The stream, though half shaded by the dense growth along its banks, does not here flow through woods. In volume it is equal to Wilson Creek. *D. quadramaculatus* was abundant, though hard to catch because of the myriad of rocks crowding the bed. Five clusters were found as follows:

(a.) Cluster of 26 eggs in a notch on edge of one (approximately 10 x 8 x 2 in.) of three flat stones wedged edgewise between two

boulders. The stone with the eggs was so placed in relation to one of the others as to form the cavity into which the eggs were neatly fitted. Water flowed between the boulders down over the flat stones. Embryos well advanced.

(b.) Cluster of 30 eggs in a niche in one end of a small discarded stone which lay flat upon a larger one. The eggs certainly were submerged, for much of the creek flowed swiftly over the stones. Eggs in one layer.

(c.) Cluster of 30 eggs on a large irregular stone found deep in a small cascade. Eggs not in one layer. Displacement caused the embryos to struggle and many emerged just after exposure.

(d.) Cluster of 34 to 38 eggs on a large stone under a still larger one. Both well down in a small cascade. Embryos emerged in rapid succession immediately after being disturbed.

(e.) Cluster of 3 eggs on the edge of a large stone set well down in a small cascade. Eggs certainly submerged; well advanced.

"Each egg is attached to its stone by a separate gelatinous string which, at its end against the rock, may be barely confluent with another string or so. The eggs, therefore, should be considered separately attached. The two capsules are transparent. The attaching strings, being extremely elastic, have no constant diameter or length. Most of the eggs are held close down against the stone. Those of the sometimes present upper layer are drawn down against the bottom layer, the attaching strings being necessarily stretched a little. The strings or cables are attached near one point so that the typical cluster is held together in a compact mass. A lot may, however, be made up of as many as three clusters, one large and two small. The elasticity of the cables allows great freedom of movement and the eggs are readily shifted about, those in a bottom layer shifted to the top and those on top moved below. Clusters placed on a flat surface are generally spread out, i.e., in a single layer or in one large and one small layer, while those in a cavity or concavity are inclined to be more definitely piled or even bunched. When still-attached eggs are submerged in flowing water, the cables are stretched, and each egg with its extended cable behaves like a toy balloon tied before an electric fan.

"The *quadramaculatus* cluster is attached to the under surface of a stone or in some well-protected cavity or concavity. The stone may vary greatly in size and shape and the eggs may or may not be sub-

merged. Their situation will, in the vast majority of cases, have a very definite relationship to rushing or falling water in the form of a cascade or tiny waterfall. It would be imprudent to generalize beyond this.

"Measurements taken from formalin specimens may be of some value in spite of their inevitable inaccurateness:

Length of attachment of cable	3 mm.
Diameter of attachment cable	1.5 mm.
Diameter of well-advanced eggs	5-6 mm."

Remarks: The nomenclatorial status of this extremely distinct species is in some confusion. Green (1818) described a *Salamandra nigra,* without type locality. The description does *not* apply to this species, but possibly was based on an old specimen of *fuscus,* as the name was used in that connection by Harlan and by Hallowell.

The question as to whether the two specimens with Pennsylvania labels are correctly so recorded is nomenclatorially irrelevant, as Green's description does not apply and he left no type specimens of this form.

The first unquestionable references to this species are the two names of Holbrook's, *Triton niger,* and *Salamandra quadra-maculata.* Both of these are composite names, the first based on the adults of both *fuscus* and the present form, and the second on the young of both. Both plates are apparently based on the present form, but the descriptions refer equally to both. The name *niger* was taken from Green.

Holbrook certainly knew the present species as the two oldest specimens A. N. S. No. 14001 from "Penn.," and M. C. Z. No. 183 from "Charleston, S. C.," were presented by him. The former was the "only" specimen of the present form seen by Baird, who, in 1849, first distinguished between this and *fuscus.* Baird, however, used Green's name *niger,* which is inapplicable.

This is the most distinct species in the genus and there is little chance of its being confused with *phoca* to which it is nearest, but a fair chance of confusing it with *Leurognathus marmorata* which it much resembles externally.

Specimens seen 304, as follows:

Illinois: Cook County 1 (U. S. N. M. No. 3823). Probably erroneous labeling.

Pennsylvania: No locality 1 (A. N. S. No. 14001, presented by Holbrook); Meadville 1 (U. S. N. M. No. 3883). These are also dubious.

Virginia: Wytheville 1 (U. S. N. M. No. 14419); Giles Co. 9 (A. N. S. No. 916-24); White Top Mt. 29 (M. C. Z. No. 6496-501); Abingdon 2 (M. C. Z. No. 6453-4).

North Carolina: Beaver Creek, Ashe Co. 11 (Breder); Blowing Rock 52 (U. Pa.); Linville 92 (E. R. D., U. S. N. M. No. 30891-902, M. C. Z. No. 6196-231, A. M. N. H. No. 4522-3, 4526-30, 4535, 4545-52, 4768-88, 5042); Cane River 4 (Field No. 1976); Hanging Rock Mt. 1 (N. Y. Mus.); Yancey Co. 2 (U. S. N. M. No. 31115, 31118); Bald and Sampson Mts. 1 (U. S. N. M. No. 31125); Spruce Pine to Micaville 1 (U. S. N. M. No. 31131); Roan Mt. 4 (U. S. N. M. No. 45989-91, 45525); Henderson Co. 3 (A. N. S. No. 913-5); Blantyre 5 (E. R. D., M. C. Z. No. 2638, Cornell, U. S. N. M. No. 38246-7); Brevard 61 (A. M. N. H. No. 4105-13, 4126, 4192, 4352, 4362-4, 4442-51, 4464, 4477, 4479-86, 4488-91, 4511-3, U. S. N. M. No. 38306-12, 38317-9, 38327-33, 48451, 48458); Mt. Pisgah 1 (N. Y. Mus.); Pisgah Forest Reserve 3 (A. M. N. H. No. 4388-90); Sunburst 2 (E. R. D.); Heywood Gap 1 (E. R. D.); Cherokee 1 (U. S. N. M. No. 15579); Mt. Sterling 6 (M. C. Z. No. 6496-501).

Tennessee: No locality 1 (A. N. S. No. 4384); Roan Mt. 1 (A. N. S. No. 4362).

South Carolina: Abbeville 2 (U. S. N. M. No. 3923); Charleston 1 (M. C. Z. No. 183, presented by Holbrook, locality dubious).

Georgia: Rabun Co. 1 (Davis); Augusta 1 (U. S. N. M. No. 8802, locality dubious); no locality 1 (U. S. N. M. No. 3886).

It has also been recorded from the following North Carolina localities: Flat Rock (Pope 1924); Montreat, Stoney Mt., and Swannanoa Gap (Bishop 1924); Peak Mt., Sugar Mt., Linville Mt., and Linville Gap Cr. (Bishop 1925).

DESMOGNATHUS PHOCA (MATTHES)

1855 *Salamandra phoca* Matthes, Allg. deutsche naturh. Zeitschr. (N. S.). 1, p. 273.

1923 *Desmognathus phoca* Dunn, Proc. New England Zoöl. Club 8, p. 39; Stejneger and Barbour 1923, Check List (2), p. 20; Dunn 1924, Copeia 127, p. 32; Brady 1924, Copeia 126, p. 29 (eggs); Bishop 1924, New York Mus. Bull. 253, p. 93; Pope 1924, Amer. Mus. Nov. 153, p. 7 (habits and eggs) Bishop 1925, Copeia 139, p. 11.

1916 *Desmognathus monticola* Dunn, Proc. Biol. Soc. Washington 29, p. 73 (Brevard, N. C.); 1917, Proc. U. S. Nat. Mus. 53, p. 404; 1917, Bull. Amer. Mus. Nat. Hist. 37, p. 608, pl. 58, ff. 3-5; Stejneger and Barbour, 1917, Check List, p. 22; Dunn 1918, Copeia 53, p. 19; 1918, Bull. Mus. Comp. Zoöl. 62, p. 463; 1920, Proc. Biol. Soc. Washington 33, p. 132; Breder and Breder, 1923, Zoologica 4, 1, p. 17.

Type: Not known to exist.

Type locality: Taylor's Creek, near Newport, Ky.

Range: From Pittsburgh, Pa., to Toccoa, Ga., and to Newport, Ky., Piedmont; Blue Ridge, southern section; Allegheny valley, middle section; Allegheny Plateau, Kanawha section, and Connemaugh section.

Diagnosis: A *Desmognathus* with vomerine teeth present in adult males; tail keeled above; belly uniform, pale; a row of light dots between insertions of arms and legs.

Description: Adult male in my own collection; Midway, Nelson Co., Va.; 14 costal grooves, 2 costal folds between appressed toes; head width 5 in length from snout to vent; head length 3⅕ in length of body; head oval, rugose above; eye shorter than its distance from tip of snout; outline of upper jaw slightly sinuous; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove cutting off front corner of upper eyelid; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1, in order of length; toes 3, 4, 5, 2, 1, in order of length; vent lined with papillae; tail longer than body; trigonal in section at base, flattened distally, with a high keel or fin above; vomerine teeth 3 on one side, 0 on the other; parasphenoids in two series beginning at middle of eyesocket; premaxillary teeth enlarged and pointed; grayish brown above, dull gray below; a light mark from eye to angle of jaw; black spots the size of the eye scattered irregularly over dorsum; a line of light dots between arm and leg; total length 134, head 16, body 54, tail 64.

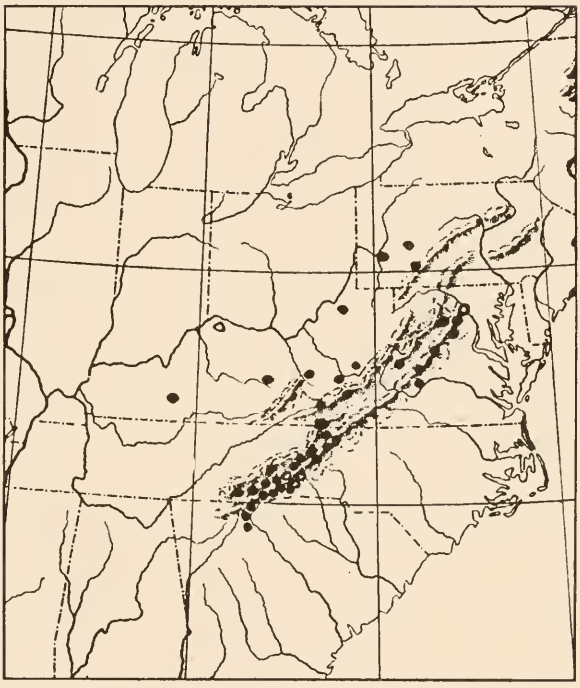
Variation: A female, same data, has 3 costal folds between the appressed toes; upper jaw straight; 6 vomerine teeth in series, separated from its fellow by twice the width of nares, and from parasphenoids by 6 times width of nares; latter in two patches beginning at hind end of eye socket; lighter in color than described male; total length 123, head 13, body 48, tail 62.

A young specimen, same data; appressed toes touching; a double series of lighter spots above, one to every three costal folds, seven on a side, extending onto tail; unpigmented below; total length 42, head 6, body 17, tail 19.

There is little variation in this species. The light dorsal spots are smaller than in *fuscus*, more persistent, and more heavily outlined with dark. Late in life they coalesce across the middorsal line and leave portions of their borders as dark spots on the dorsum. In

fuscus and its races, these spots coalesce at transformation and their borders form a dark lateral band but are absent from the light dorsal band.

In the young the belly is white. A uniform pigmentation gradually encroaches on the belly from the sides inward and from behind forward, so that the last unpigmented part of the belly is between the



3. Appalachian mountains, showing localities for Desmognathus phoca.

fore legs. Eventually the whole belly is lightly and uniformly pigmented. In a few specimens this pigmentation is fairly dark, never, however, becoming as dark as in *quadra-maculatus*. The testes are unpigmented.

The vomerine teeth show a tendency to disappear in very large and old males. They are not lost regularly at sexual maturity as in

fuscus. Females seem to be sexually mature at a total length of 105 mm., head and body 51.

I have not seen the larva but Brady (1924) says, "18 to 20 mm. long, differed from those of *fusca* in having a row of well defined light spots each side of the dorsal groove from its beginning to the base of the tail."

Measurements of a series follow: (V.T. = vomerine teeth; C.F. = costal folds between appressed toes).

Specimen	*Sex*	*Length*	*Head*	*Body*	*Tail*	*V. T.*	*C. F.*	*Locality*
E. R. D.	Male	134	16	54	64	3-0	2	Midway, Va.
M. C. Z. 2546	do	132	16	52	64	0	3½	Blantyre, N. C.
Cornell	do	106	14.5	51.5	40	0	.....	Clayton, Ga.
E. R. D.	do	112	15.5	48.5	48	2-4	3	Haywood Co., N. C.
Do	do	120	15	48	57	3-4	3	Do.
U. S. N. M. 31116	do	101	14	47	40	3-3	2½	Yancey Co., N. C.
U. S. N. M. 38253	do	135	14.5	46.5	74	3-2	3	Tatula Mt. near Highlands, N. C.
U. S. N. M. 38313	do	116	12	45	58	3-3	3	Brevard, N. C.
U. S. N. M. 38316	do	75	13	44	18	3-3	3	Do.
U. S. N. M. 31120	do	107	11.5	41.5	54	4-5	2½	Yancey Co., N. C.
E. R. D.	Female	123	13	48	62	6-6	3	Midway, Va.
Do	do	119	13.5	47.5	58	5-6	3	Blantyre, N. C.
Do	do	122	13	46	46	.....	3	Haywood Co., N. C.
U. S. N. M. 38251	do	104	12.5	45.5	46	.....	3	Wayah Bald Mt., N. C.
U. S. N. M. 38314	do	91	12	45	34	.....	3	Brevard, N. C.
U. S. N. M. 38315	do	100	12	39	49	5-5	3	Do.
U. S. N. M. 31121	do	93	11.5	34.5	47	.....	3	Yancey Co., N. C.
U. S. N. M. 48455	.....	79	9	28	42	.....	2	Brevard, N. C.
U. S. N. M. 38320	.....	58	7.5	27.5	23	.....	2	Do.
U. S. N. M. 38321	.....	63	7.5	25.5	30	.....	2	Do.
E. R. D.	.....	55	7	20	28	4-5	2	Clarke Co., Va.
U. S. N. M. 38323	.....	46	7	19	20	.....	2	Brevard, N. C.
U. S. N. M. 38324	.....	36	5.5	14.5	16	.....	.....	Do.
U. S. N. M. 38325	.....	34	5	14	15	.....	.....	Do.
U. S. N. M. 38326	.....	31	5	12	14	.....	.....	Do.

Habits: In general habitat relations this species is similar to *fuscus*. It, however, prefers darker, damper, and cooler places. Thus at Midway, Va., in 1922, I collected in several small streams tributary to the James River. In three of these *fuscus* was the only species present. These were some distance back from the river, flowing in broad valleys on top of the Piedmont Plateau. Near the river they cut gorges but as they were by that time large no *Desmognathus* were found there. In two small streams cutting directly into the bluffs *phoca* was found in company with *fuscus*, in proportions of 6 to 9, and of 34 to 9, respectively. These streams were the same size as the others in which *fuscus* alone was found, but were in much deeper gorges.

In the Carolina mountains they frequent the same sort of small stream and the brooks and springs along the roads simply teem with them. They are not found in the larger streams, big enough for a man to swim in, as is *quadra-maculatus*. I once sat on the side of a road under a tree during a rain and four or five large individuals crossed the road within an hour. While we were climbing Grandmother Mountain early one morning, one ran across our path with an earthworm in its mouth.

Brady (1924) found "near a small branch of Stone Creek, Loudoun County, Va., about 2 miles from Harper's Ferry, . . . Sept. 5. . . . a 90 mm. female coiled about 17 hatched eggs and 12 larvae. The eggs 2¼ mm. in diameter were joined together by the external membrane. The larvae had emerged from the free ends, and the egg-mass had somewhat the appearance of a honeycomb."

Pope (1924) has given an extended account of the animal at Flat Rock, N. C., which is here quoted:

"In the vicinity of Flat Rock this is the salamander commonly found in and about brooklets and streams of all sizes and called 'spring lizard' by the natives. Specimens were often taken in the woods some distance from water. It is frequently seen in protected walled-in springs and is said occasionally to gain entrance to the human mouth by way of drinking water.

"July twenty-seventh on Many Pines Plantation, East Flat Rock, with the able assistance of Mr. Bennett, the author found a cluster of thirty eggs fastened to the under-side of a stone (measuring approximately 7 x 8 x 4 inches) in the bed of a clear brook flowing through a gently sloping field. The eggs bore no sign of embryos and measured

5 mm. in diameter. An adult female under the stone was readily taken. This location was just below an open, level wood from which the brook emerges. The bed of the brook, about eight feet wide and five feet below the level of the field, is made up of sand, gravel, and small stones. The banks were covered with a dense growth of briars, weeds, and bushes which well shaded the water. The stone to which the eggs were attached, one foot from the actual flow of water, rested on pebbles, gravel, and sand just beside an eight-inch drop in the bed. At this drop the water flowed swiftly over the few obstructing stones. It should be noted that while these eggs were not in the water, they were approximately at its level and would have been well submerged by any swelling of the brook. In these mountains summer thunder showers frequently occur.

"August first at the northeast base of Trenholm Mountain in a brooklet which trickles through a level wood, the author found an adult female apparently guarding a cluster of 21 eggs, also in the early stages of development. The brooklet spreads out over the level woods floor to varying widths. An almost wholly decayed log lay in the bed. The log, ten feet long but not more than one in diameter, was covered with a growth of moss two or three inches thick. Beneath the moss, in a cavity in the remains of the log, this cluster was found adhering to the rotten wood. Between the moss and log, eight clusters of *carolinensis* eggs were found. All of these clusters were from five to eight inches above the very shallow water flowing along the log.

"The eggs of *phoca* are attached in the same manner as those of *quadramaculatus*. The twenty-one eggs found in the log were spread out more than the thirty found on the stone, but as much might have been expected. In every essential the method of egg attachment is the same in these two species."

Remarks: This species is more primitive in respect to the male sexual modifications than is *fuscus*. It is more closely related to *fuscus* than to *quadra-maculatus*, although it stands between the two.

I was unfortunately ignorant of Matthes' previous description of this form when I named it *monticola* in 1916, the name *phoca* having never been referred to in any other paper. It is a matter of considerable personal regret to me, as I caught the first specimen of it I ever saw, and it was the first species I ever described.

Specimens seen 434, as follows:

Pennsylvania: Marsh Run, Indiana Co. 1 (A. N. S. No. 18659); Chestnut Ridge, Westmoreland Co. 5 (S. C.); Harmersville, Allegheny Co. 5 (Carn. No. 143741); Pittsburgh 2 (A. N. S. No. 15217, 15225).

West Virginia: Petroleum 1 (M. C. Z. No. 1163); Clear Creek, Greenbrier Co. 2 (U. S. N. M. No. 33824-5); Star Creek 1 (U. S. N. M. No. 33636); Big Stony Creek, near Barger's Spring 1 (U. S. N. M. No. 33652); Baileysville 1 (U. S. N. M. No. 33610).

Virginia: Clarke Co. 1 (U. S. N. M. No. 3892); Berry's Ferry 1 (E. R. D.); Hanging Rock 8 (U. S. N. M. No. 50024-31); Bluemont 1 (Cornell); Delaplane 2 (U. S. N. M. No. 39024-5); Stony Man Mt. 1 (U. S. N. M. No. 29252); Thornton Gap, Page Co. 17 (U. S. N. M. No. 59899-915); Crozet 4 (M. C. Z. No. 5204-7); O'Connell's, Augusta Co. 2 (U. S. N. M. No. 36270, 36754); Nelson Co., Midway 47 (E. R. D., M. C. Z. No. 6561-65); Manteo 3 (M. C. Z. No. 6558-60); Wingina 1 (A. M. N. H. No. 5047); Giles Co. 1 (A. N. S. No. 984); White Top Mt. 9 (M. C. Z. No. 6537-45); Horsepen Cr., Tazewell Co. 1 (U. S. N. M. No. 33644).

Kentucky: Breathitt Co. 1 (M. C. Z. No. 1708); Stillhouse Br., Breathitt Co. 1 (N. Y. Mus.); Buckhorse Cr., Breathitt Co. 3 (N. Y. Mus.); Edmonson Co. 1 (M. C. Z. No. 2230).

North Carolina: Beaver Creek, Ashe Co. 86 (Breder); Linville 26 (M. C. Z. No. 6459-64, A. M. N. H. No. 4533, 4553-9, 4676, 5003-10, 5043); Blowing Rock 2 (U. Pa.); Cane River 3 (U. S. N. M. No. 31145, 31147-8); Spruce Pine to Micaville 1 (U. S. N. M. No. 31132); Burnsville 1 (U. S. N. M. No. 31123); Yancey Co. 5 (U. S. N. M. No. 31116-7, 31119, 31120-1); Weaverville 2 (M. C. Z. No. 5924-5); Blantyre 4 (E. R. D., Cornell, M. C. Z. No. 2546, U. S. N. M. No. 28248); Brevard 90 (U. S. N. M. No. 38313 TYPE *monticola*, 38314-6, 38320-6, 48452-7, 48459-62, A. M. N. H. No. 4060-87, 4130, 4176, 4180-8, 4190, 4193-9, 4338-9, 4359, 4369-78, 4440, 4463, 4465-7, 4478, 4487, 4505, 4510); Pisgah Forest Reserve 12 (A. M. N. H. No. 4392-402, 4419); Wayah Bald Mt. 1 (U. S. N. M. No. 38251); Tatula Mt. 2 (U. S. N. M. No. 38255-6); Joanna Bald Mt. 1 (U. S. N. M. No. 38250); Sunburst 3 (E. R. D.); Waynesville 51 (Chapin, S. C.); Mt. Sterling 4 (M. C. Z. No. 6455-8).

Georgia: Clayton 3 (Cornell, Davis); Toccoa 1 (Cornell); Tallulah Falls 4 (Cornell); no locality 8 (M. C. Z. No. 200,215).

It has also been recorded from Stone Creek, Loudoun Co., Va. (2 miles from Harper's Ferry) (Brady 1924); Swannanoa Gap, Montreat, Mt. Pisgah, and Stoney Mt., N. C. (Bishop 1924); Flat Rock, N. C. (Pope 1924); Peak Mt., Hanging Rock Mt., Linville Gap Cr., Sugar Mt., Linville Mt., N. C. (Bishop 1925); and Taylor's Creek, near Newport, Ky. (Matthes 1855).

DESMOGNATHUS FUSCUS FUSCUS (RAFINESQUE)

1818? *Salamandra sinciput-albida* Green, Journ. Acad. Nat. Sci. Philadelphia 1, p. 352. (New Jersey).

1818? *Salamandra nigra* Green, l. c., p. 352; Harlan 1826, same, 5, p. 332.

1842 *Triton niger* Holbrook, N. Amer. Herp. (2), 5, p. 81, pl. 27.

1856 *Desmognathus niger* Hallowell, Proc. Acad. Nat. Sci. Philadelphia, p. 11.

1856 *Plethodon niger* Hallowell, same, p. 101; 1858, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 344.

1908 *Desmognathus nigra* Nash, Vert. Ontario, p. 7; Piersol 1913, Nat. Hist. Toronto, p. 243.

1818 *Salamandra fusca* Green, l. c., p. 359 (not *Salamandra fusca* Laurenti 1768, Syn. Rept., p. 42).

1820 *Triturus fuscus* Rafinesque, Ann. Nat. 1, p. 4.

1849 *Desmognathus fuscus* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 285; Gray 1850, Cat. Batr. Grad. Brit. Mus., p. 40; Cope 1870, Amer. Nat. 4, p. 400; Wiedersheim 1877, Morph. Jahrb. 3, pl. 24, f. 92, pl. 25, f. 101, 103 (skull); Parker 1879, Trans. Linn. Soc. London (2), 2, 3, 5, p. 202, pl. 18, f. 11, pl. 21, f. 6-10 (skull); Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 77; Evermann 1918, Copeia 58, p. 67; Noble 1922, Bull. Amer. Mus. Nat. Hist. 46, pl. 20, f. 1, pl. 21, f. 1-3 (thigh muscles); Bishop 1925, Copeia 139, p. 10; Edgeworth 1925, Journ. Anat. 59, p. 228, f. 42 (chrondocranium); Humphrey 1925, Journ. Morph. 41, p. 12 (germ cells).

1854 *Plethodon fuscum* Duméril and Bibron, Erp. Gén. 9, p. 85, pl. 101, f. 3.

1917 *Desmognathus fuscus fuscus* Stejneger and Barbour, Check List, p. 22; Wright and Moesel 1919, Copeia 72, p. 64; Dunn 1920, Proc. Biol. Soc. Washington 33, p. 132; Blanchard 1922, Occ. Pap. Mus. Zoöl. U. Michigan 117, p. 4; Löding 1922, Alabama Mus. Pap. 5, p. 15; Breder and Breder 1923, Zoölogica 4, 1, p. 16; Bishop 1923, Copeia 118, p. 67; Stejneger and Barbour 1923, Check List (2), p. 19; Brady 1924, Copeia 130, p. 55; Pope 1924, Amer. Mus. Nov. 153, p. 6.

1859 *Desmognathus fusca* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 124; Verrill 1863, Proc. Boston Soc. Nat. Hist. 9, p. 197; Cope 1869, Proc. Acad. Nat. Sci. Philadelphia, p. 113; Davis 1884, Proc. Nat. Sci. Ass. Staten I. 1, p. 13; Hughes 1886, Bull. Brookville Soc. Nat. Hist. 2, p. 44; Fisher 1887, Amer. Nat. 21, p. 672; Garman 1892, Bull. Illinois Lab. Nat. Hist., p. 358; Hay 1893, 17th Rept. Indiana Geol., p. 43; Garman 1894, Bull. Essex Inst. 26, p. 37; Wilder 1894, Anat. Anz. 9, p. 216 (lunglessness); Kingsbury 1895, Proc. Amer. Micr. Soc. 17, p. 282 (spermatheca); Gaines 1895, Amer. Nat. 29, p. 55; Rhoads 1895, Proc. Acad. Nat. Sci. Philadelphia, p. 400; Sherwood 1895, Proc. Linn. Soc. New York 7, p. 21; Hopkins 1896, Amer. Nat. 30, p. 832; Brimley 1896, Amer. Nat. 30, p. 500; Murray 1897, Anat. Anz. 13, p. 664 (vertebrae); Allen 1899, Proc. Boston Soc. Nat. Hist. 12, p. 73; Cox 1899, Ottawa Nat., p. 194; 1899, Trans. Roy. Soc. Canada (2), 5, p. 141; Kingsbury 1899, Zoöl. Bull. 2, p. 203 (spermatogenesis); Wilder 1899, Amer. Nat. 33, p. 231; Morse 1901, Ohio Nat. 1, p. 114; Wilder 1901, Amer. Nat. 35, p. 183 (pharynx); Morse 1902, Ohio Nat. 2, p. 164; Kingsbury 1902,

Amer. Journ. Anat. 1, p. 99 (spermatogenesis); Britcher 1903, Proc. Onondaga Acad. Sci. 1, p. 121; Montgomery 1903, Biol. Bull. 4, p. 259 (chromosomes); Henshaw 1904, Occ. Pap. Boston Soc. Nat. Hist. 7, 2, p. 6; Wilder 1904, Amer. Nat. 38, p. 117 (embryology); Ditmars 1905, Amer. Mus. Nat. Hist. Journ. 5, 4, p. 178, f. 13; Drowne 1905, Mon. Roger Williams Park Mus. 15, p. 19; Stone 1906, Amer. Nat. 40, p. 162; Fowler 1906, Proc. Acad. Nat. Sci. Philadelphia, p. 356; 1907, Rep. New Jersey Mus. 1906, p. 74; Brimley 1907, Proc. Elisha Mitchell Sci. Soc. 23, p. 154; McAtee 1907, Proc. Biol. Soc. Washington 20, p. 15; Nash 1908, Vert. Ontario, p. 7; Kingsbury and Reed 1909, Journ. Morph. 20, p. 584, f. 13-15 (otic region); Hilton 1909, Journ. Morph. 20, p. 533 (embryology); Reed and Wright 1909, Proc. Amer. Phil. Soc. 48, p. 404; Hilton 1911, Biol. Bull. 21, p. 1 (embryology); Surface 1913, Zoöl. Bull. Pennsylvania Dept. Agric. 3, 3-4, p. 104, f. 13, pl. 7, f. 2; Wilder 1913, Biol. Bull. 24, p. 251 (life history); Deckert 1914, Copeia 13; Keim 1914, Copeia 2; Street 1914, Copeia 4; Brimley 1915, Journ. Elisha Mitchell Sci. Soc. 30, p. 5; Dunn 1915, Copeia 16; 1915, Copeia 18, p. 5; 1915, Copeia 25, p. 63; Fowler 1915, Proc. Delaware Co. Inst. Sci. 7, p. 9; 1915, Copeia 22, p. 38; Hawkinson 1915, Bull. Illinois Lab. Nat. Hist. 11, 3; Dunn 1916, Copeia 28, p. 22; Shufeldt 1916, Aquatic Life 1, 6, p. 69; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 23; Mattern and Mattern 1917, Copeia 46, p. 64; Fowler 1917, Copeia 40, p. 14; Wilder 1917, Biol. Bull. 32, p. 13 (breeding habits); Dunn 1917, Bull. Amer. Mus. Nat. Hist. 37, p. 609; 1918, Copeia 53, p. 19; Fisher 1918, Copeia 58, p. 65 (freezing); Speck 1919, Copeia 70, p. 46; Reed 1920, Journ. Morph. 33, p. 347, f. 11-14, pl. 4, f. 30 (otic region); Steiner 1921, Anat. Anz. 53, p. 516, f. 2 (tarsus); Humphrey 1921, Amer. Journ. Anat. 29, p. 222 (testis); Wilder 1923, Copeia 121, p. 88 (spermatophores); Emmel 1924, Amer. Journ. Anat. 33, p. 351, pl. 1, f. 4-6, pl. 7, f. 76-81 (erythrocytes); Brimley 1925, Copeia 139, p. 14; Fowler 1925, Copeia 145-6, pp. 58, 62, 65.

1889 *Desmognathus fusca fusca* Cope, Bull. U. S. Nat. Mus. 34, p. 194, f. 48, pl. 34, f. 5-6, pl. 36, f. 1, pl. 45, f. 7; Hay 1902, Proc. Biol. Soc. Washington 15, p. 126; Dunn 1917, Proc. U. S. Nat. Mus. 53, p. 407; 1918, Bull. Mus. Comp. Zoöl. 62, p. 463.

1820 *Triturus nebulosus* Rafinesque, Ann. Nat. 1, p. 5 (Harlem, N. Y.); 1832, Atlantic Journ. 1 ,3, p. 121.

1825 *Salamandra picta* Harlan, Journ. Acad. Nat. Sci. Philadelphia 5, p. 136 (Philadelphia, Pa.); 1826, same, p. 333; 1827, same, 6, p. 11; Linsley 1844, Amer. Journ. Sci. Arts 46, p. 50; Fogg 1862, Proc. Portland Soc. Nat. Hist. 1, p. 86.

1825 *Salamandra intermixta* Green, Hall's Portfolio 20, p. 159 (Jefferson College, Pa.); 1827, Cont. Maclurean Lyc. 1, p. 5.

1831 *Salamandra frontalis* Gray, in Griffith's Animal Kingdom 9, p. 107 (substitute for *sinciput-alba* [sic] Green).

1850 *Ambystoma frontale* Gray 1850, Cat. Batr. Grad. Brit. Mus., p. 39.

1854 *Molge brunnea* Valenciennes in Duméril and Bibron, Erp. Gén. 9, p. 86.

1854 *Molge arenatus* Valenciennes, loc. cit., p. 86.

1856 *Plethodon quadrimaculatus* Hallowell, Proc. Acad. Nat. Sci. Philadelphia, p. 11.

1895 *Desmognathus ochrophaea* Rhoads, Proc. Acad. Nat. Sci. Philadelphia, p. 400; Cox 1898, Bull. Nat. Hist. Soc. New Brunswick 4, 16, 1, p. 64.

1922 *Desmognathus fuscus auriculatus* Löding, Alabama Mus. Pap. 5, p. 15; Holt 1924, Copeia 135, p. 95; Bishop 1924, New York Mus. Bull. 253, p. 92; Brimley 1925, Copeia 139, p. 15.

Type: Not known to exist.

Type locality: Northern parts of the State of New York.

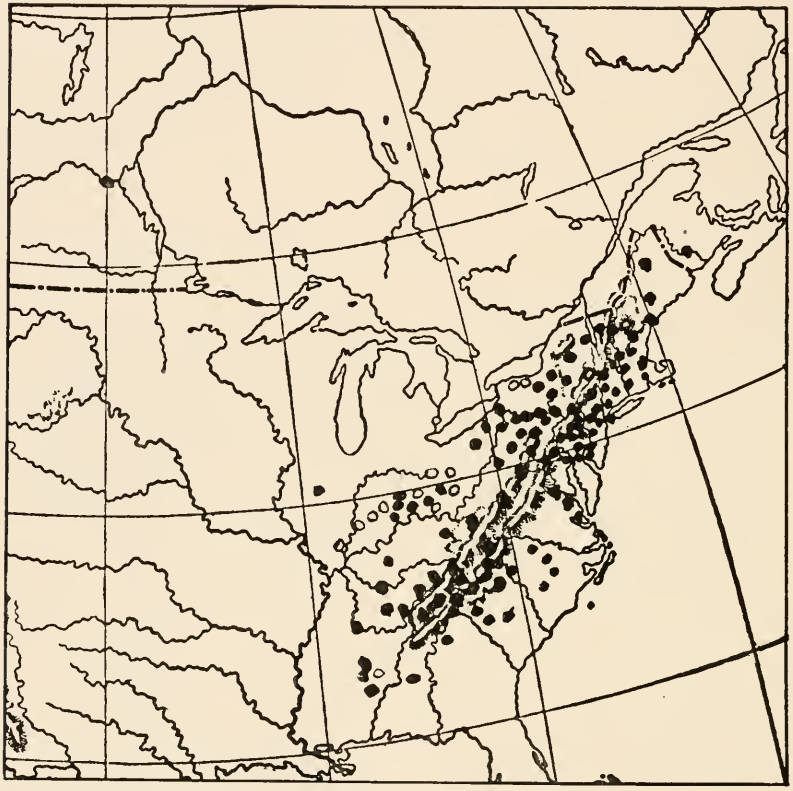
Range: St. John's River, New Brunswick, to Raleigh, N. C., Dayton, Ala., Henry, Tenn., and Normal, Ill. Manitoba?

Diagnosis: A *Desmognathus* which loses the vomerine teeth in adult male; tail trigonal, keeled above; belly mottled, light; no light spots on sides.

Description: Adult male; Midway, Nelson Co., Va., my own collection; 14 costal grooves; 4 costal folds between appressed toes; head width 5½ in length from snout to vent; head length 3 6/7 in length of body; head oval; eye shorter than its distance from tip of snout; outline of upper jaw sinuous; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove across front corner of upper eyelid; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 3, 4, 5, 2, 1 in order of length; vent papillate; tail trigonal at base, flattened at tip, keeled but not finned above, longer than body; parasphenoid teeth in two patches confluent anteriorly, beginning at hinder third of eyesocket; no vomerine teeth; premaxillary teeth enlarged, pointed; rufous brown dorsally, black spots form irregular mid-dorsal and dorsolateral series; on sides grayish brown fading gradually into the dirty white of the ventral surface; some mottling of black on sides; a white mark from eye to angle of jaw; total length 130, head 14, body 54, tail 62.

Variation: An adult female, same data, differs as follows: head width 5⅘; head length 3½; vomerine teeth in series of 5, beginning behind inner edge of nares, separated from its fellow by twice width of nares and from parasphenoids by four times width of nares; outline of upper jaw straight; parasphenoids beginning at middle of eyesocket; no papillae in vent; premaxillary teeth normal; a dark gray band on sides, edge crenulate above, fading below; lighter grayish brown on dorsum; belly light, mottled with gray; total length 107, head 11.5, body 40.5, tail 55.

A young specimen, same data, has three costal folds between appressed toes; tail shorter than body; light below; a dark lateral band with wavy dorsal edge; a mid-dorsal row of dark spots; a line of light dots between arm and leg; total length 35, head 5, body 16, tail 14.



4. Eastern North America, showing localities for Desmognathus fuscus fuscus.

A larva, same data, has uniform pigmentation above save for paired dorsolateral light spots; light below; total length 26, head 3, body 12, tail 11.

The parasphenoids are frequently completely separated. The tail is longer in females than in males. The male is larger than the fe-

male. The largest male seen has head and body 68 mm. long, and the largest female has head and body 52 mm. long.

The color pattern is distinctive on account of the early confluence of the dorsolateral light spots on the tail, which takes place at or before transformation, and the usually complete confluence of them on the body shortly after transformation. Thus there is invariably a light line on the dorsum of the base of the tail, and usually a light dorsal band on the body, in transformed individuals.

The species is smaller in the north than in the south, the light spots become earlier and more completely confluent, and the dorsal area is not so light in color in the north as in the south. These differences are not sufficiently marked to be distinctive.

Measurements of a series from my own collection follow: V. T. = number of vomerine teeth. C. F. = number of costal folds between the appressed toes.

Sex	*Length*	*Head*	*Body*	*Tail*	*V. T.*	*C. F.*	*Locality*
Male	134	14	54	66	0	4½	Raleigh, N. C.
do	128	14	53	61	0	.....	Conshohocken, Pa.
do	116	13	52	51	0	4	Haverford, Pa.
do	109	14	51	44	0	4	Midway, Va.
do	119	12	50	57	0	4	Haverford, Pa.
do	94	12	48	34	0	4¼	Do.
do	113	13	48	52	0	4	Midway, Va.
do	100	12	46	42	0	4	Haverford, Pa.
do	109	11	45	53	0	4	Do.
do	104	11	41	52	0	4	Clarke Co., Va.
do	96	10	40	46	2-2	4	Haverford, Pa.
do	99	10.5	38.5	50	1	4	Clarke Co., Va.
do	81	11	36	33	0	4	Do.
do	83	9	34	40	2-2	4	Haverford, Pa.
do	73	9	33	31	2-2	4	Do.
do	72	9	30	33	4-5	4	Midway, Va.
do	71	9	30	32	4-4	4	Haverford, Pa.
do	63	7.5	28.5	27	6-6	4	Do.
do	67	8	28	31	4-4	4	Do.
do	65	7	26.5	31.5	6-6	4	Do.
do	61	7	25	29	4-3	4	Do.
do	53	6.5	21.5	25	4-4	4	Do.
Female	100	10	42	48	3-3	4½	Do.
do	102	9.5	41.5	51	6-3	4	Do.
do	107	11.5	40.5	55	3-4	4½	Midway, Va.
do	93	9	40	44	3-4	5	Haverford, Pa.

Female	91	9.5	37.5	44	5-6	4	Haverford, Pa.
do	81	8	35	38	3-3	5	Do.
do	81	8	32	41	5-2	4	Do.
do	75	8	31	36	3-3	4	Do.
do	62	7	28	27	.....	4	Do.
do	64	7.5	25.5	31	.....	4	Clarke Co., Va.
do	60	7	25	28	3-3	4	Do.
do	58	7	23	28	3-3	4	Haverford, Pa.
do	52	6.5	20.5	25	.....	3	Clarke Co., Va.
do	39	6	20	13	.....	4	Haverford, Pa.
do	43	6	19	18	.....	.....	Do.
do	39	5	17	17	.....	.....	Do.
do	32	5	15	12	.....	.....	Do.
do	27.5	4.5	14	9	.....	.....	Clarke Co., Va.
Larva	44	5	19	20	.....	.....	Haverford, Pa., May 28
do	33.5	4.5	15	14	.....	.....	Do.

Habits: I quote from Mrs. Wilder (1913):

"*Desmognathus fusca* is terrestrial to the extent that it lives in and upon moist earth, where it mates and lays its eggs, and where the first few days of the larval life are spent. The young larvae, however, soon reach shallow running water where they remain for nearly a year, after which they come out of the water to live the terrestrial adult life of the species. The presence of aquatic as well as terrestrial insect forms in the stomachs of adult *Desmognathus* shows, however, that even the adults are by no means absolutely terrestrial, but so far as my own observations and those reported by others go, the adults confine their aquatic excursions to very shallow water, and they are seldom found in the water at all unless driven there.

"Apparently, the ideal environmental conditions for *Desmognathus fusca,* as deduced from a study of those localities in which they occur in the greatest abundance, are those afforded by the banks of well shaded streams of shallow, perennially running water. In such places they may usually be found under every stick and stone and fallen log at or below the water level, while the soft earth is riddled with burrows, often, it is true, the work of earthworms or of other animals, but utilized as convenient lurking places for *Desmognathus;* for the adult *Desmognathus* is, in the day time, at least, thigmotropic, and will even take refuge in a bottle left lying on the surface of the soil exposed to the light, usually orienting the body with the head toward the mouth of the bottle. *Desmognathus* has the power to make its own burrows, as it will demonstrate, sooner or later, when isolated in a terrarium which affords no other suitable means of protection. In one case in particular which came under my observation, two individuals were accidentally set aside in a terrarium which was supposed to contain no specimens. Over a year afterwards it was found that these animals were still living in this terrarium under almost perfectly dry conditions. In the soil were many well formed burrows, within which the specimens, which were kept for some time after they were discovered, remained, often completely concealed, but at times with the head protruding from the entrance to the burrow.

"Under natural conditions the crevices and burrows inhabited by *Desmognathus* are, of course, very moist, and I have usually been able to demonstrate, by following them carefully through their windings and branchings, a connection with the water of the neighboring brook."

Surface (1913) and Mrs. Wilder (1913) give accounts of the food of *fuscus;* Surface tabulating the contents of 235 stomachs, Mrs. Wilder of 18.

The food is composed of insects, arachnids, earthworms, snails, and isopods. Mrs. Wilder shows that cannibalism is occasionally indulged in, and that they eat their own moulted skin, as do toads and frogs. Surface found nemotodes in two stomachs, but does not say whether they were parasites or not. I have found mites encysted under the epidermis in some specimens.

There are two observations on the mating of this animal. Both are by Mrs. Wilder and the following passage is from her paper on the life history (1913).

"On the evening of May 13, 1908, I isolated in a small terrarium a large male, and a female through the abdominal wall of which large eggs could be seen. It was discovered the next morning, however, that another smaller male was also present in the terrarium, probably having been carried over unobserved in transferring some wet leaves. On the following morning, May 14, the female and this smaller male were found lying upon the earth under some wet leaves, the ventral surfaces of the bodies in contact. They reacted so quickly, however, to the disturbance of the leaves that beyond this very hasty observation as to their general positions I can state nothing definite as to methods of clasping or exact regions of contact. Protruding from the cloaca of the female was a yellowish, semi-fluid mass which was found upon examination to be a spermatophore of very soft consistency."

The possibility of a different type of impregnation is suggested by the following passage from Mrs. Wilder (1923):

"On May 14 to 16, 1915, there were collected from Bears' Den Brook on Mount Toby, in Sunderland, Mass., several adult *Desmognathus fusca,* some very large, others smaller, and a few very small ones. Ten or twelve of these were kept unassorted in shallow water in a covered glass crystallizing dish until May 20, when it was observed that in the water, which looked rather foul, there were several creamy white masses of irregular shape, measuring about one millimeter in diameter. These proved upon microscopic examination to be masses of spermatozoa constituting poorly formed spermatophores. One rather small individual which was assumed to be a male, showed such a mass protruding from its cloaca. This specimen

was at once removed from the dish and placed with three large gravid females in another dish of water for further observation. A few hours later the spermatophore unfortunately became detached by adhering to the moult layer which the animal was in the act of casting off. This individual was, however, left with the three females until July 1, when upon being killed and examined, it was found not to be a male but a female with half-grown eggs, and with empty spermatheca. Obviously, then, the spermatophore which had been observed protruding from its cloaca on May 20, had been taken up by the animal, though unsuccessfully, owing to the fact of the moulting process which was in progress. Whether this spermatophore had been taken up from the water, or had been transferred to the cloaca of the female directly from the cloaca of one of the males, is a matter which, of course, cannot be determined, but the presence of so many spermatophores in the water suggests the probability that the spermatophore had been taken into the cloaca of the female after having been deposited in the water by the male, as is the usual method in internal fertilization under aquatic conditions. If such be the case, it is probable that both the direct and the indirect method of impregnation of the female obtain in this species, the former operative when the individuals find themselves under purely terrestrial conditions, the latter, which is of course the more primitive method, being employed under aquatic conditions. In any case the fact that a spermatophore was found in the cloaca of an unripe female shows that impregnation may occur long before the actual ovulation, although it does not prove that these same spermatozoa would have remained functional until egg-laying occurred."

The egg-laying habits near Northampton, Mass., are here quoted from Mrs. Wilder (1913):

"In western Massachusetts, in the immediate vicinity of Northampton I have found eggs as early as the eleventh of June and as late as the twenty-fourth of September, although, since in the latter instance the eggs were just at the point of hatching, they were probably deposited during the latter part of August. As reported by H. H. Wilder ('04) eggs have been deposited by individuals in captivity in the Smith College laboratory as early as June first. It is thus safe to state that the egg-laying period extends at least from the first of June to the last of August and possibly through September. As suggested by Hilton, temperature and humidity may have much to do with de-

termining the exact time, and it should be further noted in this connection that the latest brood of my own observations, that of September 24, 1907, occurred at the end of a singularly cold summer, and may have been belated from that cause.

"The eggs are laid in a small batch consisting usually of two masses and numbering about 20 in all (15-20 according to Hilton), a number which corresponds in general also to the count of the ripe eggs found in the ovaries of a large number of females which I have examined for purposes of comparison. The total number is practically constant, being 10 or 11 in each ovary. A few show a smaller number or a greater inequality, such as the case of 9 in the left and 5 in the right ovary, or of 13 in the left and 4 in the right ovary."

[In a series of my own collecting from Haverford, Pa., females just matured at a length of 80 mm. had usually 28 eggs in the ovaries, while larger females up to 100 mm. had as many as forty eggs. Cope (1889) states that 18 to 30 eggs may be found on one side].

"The eggs are laid in a little moist hollow or cavity, often of accidental occurrence, in just such places, in fact, as those in which the adult *Desmognathus* is usually found. I have observed that the female in captivity will sometimes excavate in the soft earth underneath a stone or clump of moss a cavity sufficiently large to accommodate her body in a coiled position, and in this cavity will deposit her eggs. In nature, I have found eggs under a mere covering of moss or a little decaying stick. Hilton ('09) reports that they are found also at a depth of as much as four feet below the surface. They seem never to be deposited more than two or three feet from the edge of the water, or more than a few inches above its level in the neighboring brook, into which the newly hatched larvae are destined to find their way.

"So far as my own observations and those reported by others go, the eggs are laid during the night or in the early morning, as would indeed be expected from the nocturnal habits of the species. No cases have been reported of the prolongation of the process of egg-laying beyond the single night during which, apparently, all the eggs produced by a given female for one season are deposited.

"The eggs are always found guarded by a female, undoubtedly the mother. She usually so places herself among them as to bring practically all of the eggs in contact with her body, which often extends

through the mass of eggs and is frequently bent sharply upon itself as if the better to surround the protect them. When under observation, as in a terrarium, the mother frequently leaves the eggs when disturbed, always retreating through the same exit from the nest. After having been separated from the eggs, however, as may occur in making a transfer from out of doors to the laboratory, the mother goes back to them again, even though the nest and all of its surroundings may have been reconstructed.

"The egg membranes, already very carefully described by previous writers, are three in number, the outer one being continued into a stalk which connects the eggs with the others, and is thus a common membrane for the whole mass.

"The eggs themselves are creamy white, unpigmented spheres, each measuring from 3.5 to 4 mm. in diameter."

The period from laying to hatching is about eight weeks. When hatched the larvae measure 15 mm. There is a terrestrial larval stage of 15 to 16 days. At the expiration of this period the length is about 20 mm. and the larvae enter the water.

Mrs. Wilder gives the length of 15 aquatic larvae, collected in Massachusetts during November and December, as ranging between 17 and 25.5 mm. Seventeen larvae collected November 28, in Nelson County, Virginia, ranged from 21 to 29 mm.

The aquatic larval period lasts about nine months. They transform during May and June. Thus during July and August, as a rule, no larval *fuscus* will be found.

Mrs. Wilder gives the largest larva seen as 33 mm., and the smallest transformed specimen as 27.75 mm. This is at Northampton, Massachusetts. At Haverford, Pennsylvania, I have found larvae as large as 44 mm., and transformed specimens as small as 32 mm.

Mrs. Wilder says: "Specimens of 68 mm. and over of both sexes are sexually mature, apparently after three years of adult life." At Haverford they reach a larger size before maturity, although the age is probably the same. Females with developed eggs are not found smaller than 75 to 80 mm. The males lose the vomerine teeth at about 85 mm. This would be coincident with sexual maturity.

Remarks: This form is probably the commonest salamander of the family. Many more specimens have been seen of it than of any other form.

Actual intergrades between this and *carolinensis* have been seen from Flat Rock, N. C. They are considered under *carolinensis*.

Intergrades between this and *auriculatus* have been seen from Lake Drummond, Va., Raleigh, Magnolia, and Kinston, N. C., and Columbia, S. C. The Lake Drummond specimen is considered under *auriculatus*, the rest under *fuscus*.

The Manitoba specimen has every indication of authentic provenance but is under the suspicion that every isolated record must bear and needs additional confirmation.

The relationships between this and *auriculatus*, *carolinensis*, and *ochrophaeus*, are treated under the headings of those races.

Its relationships with *phoca* in the places where the two meet are treated under *phoca*.

Specimens seen 3,165, as follows:

Canada: Oromocto, New Brunswick 2 (A. N. S.); Cedar Lake, Manitoba 1 (M. C. Z. No. 1572).

Maine: Allegash Mt. 1 (Bowd. No. 216); Rangeley 8 (M. C. Z. No. 2082); Brooklin 5 (U. S. N. M. No. 39001-5); Manchester 25 (Bowd. No. 48, 94, 104. 139. 161, Pope No. 8, 27); Winthrop 7 (Bowd. No. 6, 54-5, 61, Pope No. 16); Norway 2 (M. C. Z. No. 1569); Denmark 1 (Portland No. 601); Topsham 7 (Bowd. No. 75); Brunswick 9 (Portland 608-9, Bowd. No. 60, 67, 73, 76); Westbrook 5 (U. S. N. M. No. 17836, Portland No. 605-6, 623, 635); North Gorham 1 (Portland No. 599); Braunfield 1 (Portland No. 600); Cape Elizabeth 3 (Portland No. 602-4); Oxford Co. 1 (U. S. N. M. No. 57256).

New Hampshire: North Conway 3 (M. C. Z. No. 1166); Amherst 3 (M. C. Z. No. 1165, 1167); Tilton 12 (Field No. 2484); Peterboro 2 (E. R. D.); Blair 1 (M. C. Z. No. 4583).

Vermont: St. Johnsbury 2 (U. S. N. M. No. 39541-2); Caledonia Co. 4 (Carnegie No. 779-81, 1409); Burlington 1 (M. C. Z. No. 1160).

Massachusetts: Newburyport 1 (E. R. D.); Ipswich 1 (M. C. Z. No. 7681); Cambridge 1 (U. S. N. M. No. 13401); Lunenburg 1 (E. R. D.); Mt. Toby 59 (S. C., E. R. D.); Petersham 1 (M. C. Z. No. 7047); Springfield 3 (M. C. Z. 1990, 2087, Springfield No. 41); Northampton 36 (S. C., E. R. D.); Florence 5 (E. R. D.); Williamsburg 5 (E. R. D.); Ashfield 5 (E. R. D.); Chester 1 (Blanchard); Hoosac Mts. 1 (U. S. N. M. No. 62249); Berkshire Hills 3 (A. N. S. No. 13980, 14029); Williamstown 3 (M. C. Z. No. 8824-6); no locality 2 (U. S. N. M. No. 55021-2).

Rhode Island: Providence 1 (A. M. N. H. No. 601).

Connecticut: Norfolk 1 (U. S. N. M. No. 9301); Middletown 2 (Wesleyan No. 567, 579); New Haven 1 (M. C. Z. No. 4470); Redding 1 (A. M. N. H. No. 1128).

New York: Adirondack 1 (U. S. N. M. No. 3912); Westport 36 (U. S. N. M. No.

3915); Tupper Lake 1 (M. C. Z. No. 4461); Catskills 17 (U. S. N. M. No. 23182-90, 23193-9, 23201); Haines Falls 4 (A. N. S.); Shokan 8 (A. M. N. H. No. 425, 427-8, 464); Orange Co. 1 (U. S. N. M. No. 42788); Highland Falls 16 (U. S. N. M. No. 23222-37); Garrison 12 (A. M. N. H. No. 447); Van Cortlandt Park 1 (A. M. N. H. No. 1095); Staten I. 24 (A. M. N. H No. 467); Long I. 43 (A. M. N. H. No. 894-8, 900-15, 917-8); Mohawk 9 (Carnegie No. 1661-6, 1673-5); Berkshire 13 (M. C. Z. No. 174, 231, 156. 1161, 4584-90); Utica 5 (M. C. Z. No. 4462-6); Oneida Co. 2 (Roy. Ontario Mus.); Auburn 3 (Cornell); Ovid 1 (M. C. Z. No. 1158); Ithaca 24 (U. S. N. M. No. 39409-10, M. C. Z. No. 4467-8, 4991, Cornell); Hamburg 6 (Cornell).

New Jersey: Fort Lee 16 (A. M. N. H. No. 340, 472); Ridgewood 3 (M. C. Z. No. 2409-10); Montclair 4 (A. M. N. H. No. 499, 536); Maplewood 2 (Cornell); Morristown 15 (A. N. S.); Swartswood Lake 2 (A. N. S.); Culver's Lake 2 (Carnegie No. 3077-8); Orange 11 (U. S. N. M. No. 3882); Plainfield 10 (M. C. Z. No. 2306); Scotch Plains 6 (Cornell); Trenton 1 (A. N. S.); Big Timber Creek 1 (A. N. S.); Clement's Bridge 10 (A. N. S.); Pennsville 111 (A. N. S.).

Pennsylvania: No locality 37 (A. N. S.); Susquehanna Co. 1 (A. N. S.); Bower 1 (Carnegie No. 1651); Northampton Co., Belfast 2 (A. N. S.); Lehigh Co., Lehigh Gap 8 (A. N. S.); Berks Co., Monocacy 3 (A. N. S.); Montgomery Co., Conshocken 10 (E. R. D.); Ogontz 2 (E. R. D.); Devon 7 (A. N. S.); Lafayette 2 (A. N. S.); Gladwyn 17 (A. N. S.); Mill Creek 29 (A. N. S.); Philadelphia Co., Philadelphia 73 (U. S. N. M. No. 3769, A. N. S.); Olney 1 (A. N. S.); Overbrook 3 (A. N. S.); Fairmount Park 17 (A. N. S.); Banks of Schuylkill 74 (A. N. S.); Bustleton 6 (A. N. S.); Frankfort 1 (A. N. S.); Axe Factory Run 14 (A. N. S.); Holmesburg 19 (A. N. S.); La Grange 2 (A. N. S.); Delaware Co., Haverford 74 (E. R. D.); Wawa 2 (A. N. S.); Landsdowne 1 (A. N. S.); Whitstone Run 3 (A. N. S.); Chester Co. 14 (A. N. S.); Londongrove 4 (M. C. Z. No. 6439-42); Bucks Co., Langhorne 1 (A. N. S.); Lancaster Co., Peter Creek 4 (A. N. S.); Paradise 3 (A. N. S.); Columbia Co. 1 (U. S. N. M. No. 3905); Mifflin Co., Newton Hamilton 8 (A. N. S.); Juniata Co., Tuscarora 1 (A. N. S.); Perry Co., Fox Hollow 3 (A. N. S.); Cumberland Co., Carlisle 473 (U. S. N. M. No. 3916, 7901); York Co., Peach Bottom 1 (A. N. S.); Northumberland Co., Sunbury 1 (M. C. Z. No. 1159); Clinton Co. 2 (A. N. S.); Haneyville 22 (Carnegie No. 771, 1310-30); Center Co. 1 (M. C. Z. No. 1164); Potter Co., Brooklyn 1 (A. N. S.); Seven Bridges 4 (A. N. S.); McKean Co., Port Alleghany 11 (A. N. S., U. S. N. M. No. 67108, 67404-10); Warren Co., Warren 4 (Carnegie No. 2755-8); White Pond 3 (A. N. S.); Indiana Co., Indiana 11 (A. N. S.); Lucus Pond 1 (A. N. S.); Brick Pond 1 (A. N. S.); Saltgiver Run 1 (A. N. S.); Two Lick Hills 1 (A. N. S.); Two Lick Creek 1 (A. N. S.); Blair Co. 1 (Carnegie No. 773); Broad Top Mt. 14 (A. N. S.); Plain and Portage R. 12 (Carnegie No. 759-70); Crawford Co., Centerville 1 (A. N. S.); Meadville 30 (U. S. N. M. No. 3883); Beaver Co., Smith's Ferry 2 (Carnegie No. 1640-2); Allegheny Co., Pittsburgh 22 (U. S. N. M. No. 3893,

Carnegie No. 755-8, 1171-5, 1407-8, A. N. S.); Harmerville 2 (Carnegie No. 1442-3); Hallam 38 (Carnegie No. 3129-48); Bakerston 2 (Carnegie No. 1647-8); Squaw Run 60 (Carnegie No. 782-817, 1190-210, 1402-3, 1652); Carnegie 40 (Carnegie No. 1654, 1225-73); Elizabeth 6 (Carnegie No. 1655-60); McKees Rocks 1 (Carnegie No. 2759); McKeesport 99 (Carnegie No. 977-1075); Emsworth 32 (Carnegie No. 819-50); Boston 71 (Carnegie No. 854-70, 901-40, 1276-309); Sewickley 35 (Carnegie No. 941-75); Coraopolis 40 (Carnegie No. 1076-1125); Pine Creek 19 (Carnegie No. 1152-70); Bridgeville 15 (Carnegie No. 1331-45); Montour Run 7 (Carnegie No. 1346-52); Pitcairn 12 (Carnegie No. 1353-64); Puckety Cr. 5 (Carnegie No. 1397-401); Moon 2 (Carnegie No. 1410-1); Westmoreland Co., Laughlintown 9 (Carnegie No. 1412-3, 1416-7, 1426); Fayette Co., Ohiopyle 1 (Carnegie No. 1365); Greene Co., Waynesburg 3 (A. N. S.).

Delaware: Brandywine Cr. 2 (A. N. S.); Greenville 3 (A. N. S.).

Maryland: Gloucester 2 (U. S. N. M. No. 14477); Brookville 1 (U. S. N. M. No. 4843); Laurel 1 (U. S. N. M. No. 3015); Great Falls 3 (U. S. N. M. No. 17338, 17340-1); Jennings 1 (A. N. S.); Cecil Co., Pusey Cr. 1 (A. N. S.); Dove Run 1 (A. N. S.); Conowingo 1 (A. N. S.).

District of Columbia: Washington 18 (U. S. N. M. No. 7380, 13317, 25150); Takoma Park 9 (U. S. N. M. No. 17100-2, 17105-11).

Virginia: Fairfax Co. 6 (U. S. N. M. No. 29167-72); Camp Humphries 1 (U. S. N. M. No. 66477); Munson's Hill 2 (E. R. D., U. S. N. M. No. 17667); Ashgrove 1 (U. S. N. M. No. 38192); Bailey's Cross Roads 3 (M. C. Z., No. 2095, E. R. D.); High School 1 (E. R. D.); Holmes Run 1 (E. R. D.); Dyke 2 (U. S. N. M. No. 55465, 55482); Mt. Vernon 1 (E. R. D.); Great Falls 1 (Blanchard); Arlington Co., Four Mile Run 8 (E. R. D., U. S. N. M. No. 23973); Arlington 1 (E. R. D.); Fort Myer 5 (U. S. N. M. No. 22433-7); Clarke Co. 1 (U. S. N. M. No. 3892); Berry's Ferry 27 (E. R. D.); Loudoun Co. 1 (U. S. N. M. No. 66485); Fauquier Co., Delaplane 1 (Cornell); King George Co., Somerset Beach 1 (U. S. N. M. No. 45875); Warwick Co., Rock's Warf 2 (Cornell); Danville 2 (M. C. Z. No. 1839); Page Co., Thornton Gap 2 (U. S. N. M. No. 59892-3); Stony Man Mt. 24 (U. S. N. M. No. 29253-64, 31624-6, 31628, 33887-94); Madison Co., Stony Man Mt. 1 (U. S. N. M. No. 29298); Albemarle Co., Crozet 3 (M. C. Z. No. 5208-10); Nelson Co., Wingina 7 (A. M. N. H. No. 5944-6, 5048-51); Midway 96 (E. R. D., M. C. Z. No. 6546-57); Augusta Co., Endless Caverns 56 (S. C.); Staunton 17 (Field No. 1901); Deerfield 1 (A. N. S.); O'Connell's 9 (U. S. N. M. No. 36721, 36724-5, 36734-6, 36749, 36751, 36784-5); Natural Bridge 1 (U. S. N. M. No. 36717); Bedford Co., Peaks of Otter 3 (U. S. N. M. No. 36714-6); Lynchburg to Otter Peaks 1 (M. C. Z. No. 1429); Bath Co., Nimrod Hall 1 (E. R. D.); Wytheville 1 (U. S. N. M. No. 14446); Giles Co. 8 (A. N. S. No. 980-3, 985-8); Abingdon 25 (M. C. Z. No. 6465-89); White Top Mt. 14 (M. C. Z. No. 6232-45).

North Carolina: Beaver Creek, Ashe Co. 15 (Breder); Hanging Rock Mt. 1 (N. Y. Mus.); Asheville 9 (E. R. D.); French Broad R. 1 (A. N. S.); Waynesville 41 (Chapin. S. C.); Catawba Co. 1 (M. C. Z. No. 1383); Salem 10 (U. S.

N. M. No. 3909, 3919); Raleigh 44 (E. R. D., U. S. N. M. No. 16637-53, 19946-61, A. M. N. H. No. 678, M. C. Z. No. 4723); Kinston 5 (U. S. N. M. No. 8332); Magnolia 2 (Cornell); no locality 1 (A. M. N. H. No. 1098).

South Carolina: Columbia 14 (U. S. N. M. No. 8809); Anderson 1 (U. S. N. M. No. 3880); Abbeville 9 (U. S. N. M. No. 3904, 39451-4).

Georgia: Clayton 3 (Davis); Mt. City Gap 1 (Cornell); Thompson's Mills 1 (U. S. N. M. No. 40010); no locality 22 (M. C. Z. No. 155, 163, 4569-70, U. S. N. M. No. 5039).

Alabama: Florence 4 (U. Ala., E. R. D.); University, Tuscaloosa Co. 1 (U. Ala.); Anniston 19 (M. C. Z. No. 6518-36); Dayton 1 (U. S. N. M. No. 3921); Eutaw 5 (U. S. N. M. No. 3908); Auburn 1 (A. N. S.).

West Virginia: Barrenshe Cr., MacDowell Co. 1 (U. S. N. M. No. 33643); Kegley, Mercer Co. 6 (U. S. N. M. No. 33654-9); Big Spring Run, Pocahontas Co. 1 (U. S. N. M. No. 33630); Rich Mt., near Beverley 2 (U. S. N. M. No. 33645, 33647).

Ohio: Columbus 10 (U. S. N. M. No. 3896); Highland Co. 1 (U. S. N. M. No. 3914); Trumbull Co. 3 (Field); Cincinnati 15 (U. S. N. M. No. 8819, 8831).

Indiana: Brookville 1 (U. S. N. M. No. 4843); Richmond 14 (U. S. N. M. No. 17485); Hanover College, Jefferson Co. 18 (A. N. S.).

Illinois: Normal 3 (M. C. Z. No. 2054, 2056).

Kentucky: Morgan Co. 3 (U. S. N. M. No. 35732, 36406, 37358); Cumberland Gap 3 (M. C. Z. No. 2223, 4667-8); Stillhouse Br., Breathitt Co. 2 (N. Y. Mus.); Quicksand, Breathitt Co. 12 (N. Y. Mus.); Peterson's Pt., Nelson Co. 3 (N. Y. Mus.); Edmonson Co. 1 (M. C. Z. No. 2229); Bee Spring 1 (M. C. Z. No. 1466); no locality 8 (M. C. Z. No. 2085, 4743-4).

Tennessee: Claiborne Co. 1 (U. S. N. M. No. 8829); Greenville 1 (U. S. N. M.); Erwin 1 (Biol. Surv.); Knoxville 2 (M. C. Z. No. 222, U. S. N. M. No. 3866); Spring City 15 (M. C. Z. No. 6591-605); Matlock Spring near Athens 1 (U. S. N. M. No. 21137); Sawyer's Springs, Hamilton Co. 6 (A. N. S.); Franklin Co. 3 (U. S. N. M. No. 8828, 37357); Nashville 52 (E. R. D.); no locality 1 (U. S. N. M. No. 8823).

It has also been recorded from the following additional localities:

Canada: New Carlisle, Gaspé (Cox 1899, based on larvae and probably erroneous); S. W. Ontario (Nash 1908).

Maine: Greenwood and Paris Hill (Verrill 1862-3).

New Hampshire: Intervale (Allen 1899).

Massachusetts: Worcester (Horr in litt.).

Rhode Island: Scituate (Drowne 1905).

Connecticut: East Hartford and Ayres (Linsley 1844).

New York: White Plains (Deckert 1914); Harlem (Rafinesque 1820); West Park, Ulster Co. (Fisher 1918); Albany Co. (Bishop 1923); Onondaga Co. (Britcher 1903); Wayne Co., Monroe Co. (Wright and Moesel 1919).

New Jersey: Beverly (Street 1914); Kinkora Cr. near Bordentown (Fowler 1907).

Pennsylvania: Wayne Co., Honesdale; Pike Co., Odin; Bradford Co., New Albany (Surface 1913); Troy, Columbia Crossroads; Tioga Co., Blossburg (Bishop 1925); Wellsboro (Surface 1913); Sullivan Co., Lincoln Falls, Hillsgrove;

Lycoming Co., Loyalsock, Barbours (Bishop 1925); Davistown, Williamsport; Montour Co., Danville; Carbon Co., Weissport; Northampton Co., Easton, Bethlehem, Portland; Lehigh Co., Allentown (Surface 1913); Emaus, Summit Lawn, Slatedale, Aineyville (Mattern and Mattern 1917); Berks Co., Reading, Stouchsburg; Bucks Co., Buckingham, Yardley (Surface 1913); Bristol, Wycombe, Hulmsville, Woodbourne (Fowler 1917); Montgomery Co., Bryn Mawr, Norristown; Delaware Co., Wayne (Surface 1913); Fawkes Run, Chad's Ford, Concordsville, Collar Brook, Naylor's Run, Cobb's Cr. (Fowler 1915); Perry Co., Marshrun; Dauphin Co., Berrysburg, Williamstown, Peters Mt., Dauphin, Harrisburg, Rockville, Camp Hill; Cumberland Co., Camp Hill, Enola; York Co., York, New Salem, Pigeon Hills; Adams Co., Zora; Franklin Co., Mercersburg, Mont Alto; Huntingdon Co., Huntingdon (Surface 1913); Charteroak (Bishop 1925); Fulton Co., Emmaville, McConnellsburg; Center Co., State College (Surface 1913); Laurel Run (Bishop 1925); Clearfield Co., Glenhope; Cambria Co., Johnstown, Wilmore; Indiana Co., Shelocta; Venango Co., Emlentown, Cherrytree; Beaver Co., Beaver; Allegheny Co., Munhall, Swissvale, Wilkinsburg; Westmoreland Co., Welty; Washington Co., Canonsburg, Hickory, Crothers, Washington (Surface 1913); Jefferson College (Green 1825).

Delaware: Shellpot Run, Brown's Branch (Fowler 1925).

Maryland: Cecil Co., Piney Cr., Bacon Hill, Singerly (Fowler 1915); Principio Furnace, Swan Cr. (Fowler 1925).

Virginia: Petersburg (Wright in Litt.).

North Carolina: Bridgewater, Burke Co. (Bishop 1924); southern Wake Co., Lillington, Harnett Co. (Brimley 1925).

Alabama: Sand Mt., Jackson Co. (Holt 1924); Bibb Co., Madison Co. (Löding 1922).

Ohio: Jefferson (Surface 1913); Dublin, Warren Co., Sugar Grove, Youngstown, Newton Falls, Chilicothe, Licking Co., Perry Co. (Morse 1901).

Indiana: Vincennes (as extinct, Gaines 1895).

Illinois: Charleston (Hawkinson 1915, based on larvae and probably erroneous); Mt. Carmel (Garman 1892).

Kentucky: Burnside, Pulaski Co. (Garman 1894).

Tennessee: Harriman, Roane Co. (Rhoads 1895); Henry (Blanchard 1922).

DESMOGNATHUS FUSCUS AURICULATUS (HOLBROOK)

1838 *Salamandra auriculata* Holbrook, N. Amer. Herp. 3, p. 115, pl. 28; id. (2), 5, p. 47, pl. 12.

1849 *Desmognathus auriculatus* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 286; Gray, Cat. Batr. Grad. Brit. Mus., p. 40; Lönnberg 1896, Zoöl. Anz. 19, p. 34 (lunglessness).

1894 *Desmognathus auriculata* Lönnberg 1894, Proc. U. S. Nat. Mus. 17, p. 337.

1854 *Cylindrosoma auriculatum* Duméril and Bibron, Erp. Gén. 9, p. 81.

1858 *Plethodon auriculatum* Hallowell, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 344.

1869 *Desmognathus fusca auriculata* Cope, Acad. Nat. Sci. Philadelphia, p. 116; 1889, Bull. U. S. Nat. Mus. 34, p. 195, f. 49; Brimley 1910, Proc. Biol. Soc. Washington 23, p. 10; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 22; Dunn 1917, Proc. U. S. Nat. Mus. 53, p. 412; 1918, Bull. Mus. Comp. Zoöl. 62, p. 464; Brimley 1925, Copeia 139, p. 15.

1882 *Desmognathus fuscus auriculatus* Boulenger, Cat. Batr. Grad. Brit. Mus. (2), p. 78; Stejneger and Barbour 1917, Check List, p. 22; Löding 1922, Alabama Mus. Pap. 5, p. 15; Stejneger and Barbour 1923, Check List (2), p. 19; Myers 1924, Copeia 131, p. 59; Schmidt 1924, Copeia 132, p. 68.

1900 *Desmognathus fusca* Beyers, Proc. Louisiana Soc. Nat. 1897-9, App. 1, p. 11; Brimley 1909, Proc. Biol. Soc. Washington 22, p. 132; 1910, id. 23, p. 10.

Type: U. S. N. M. No. 3901.

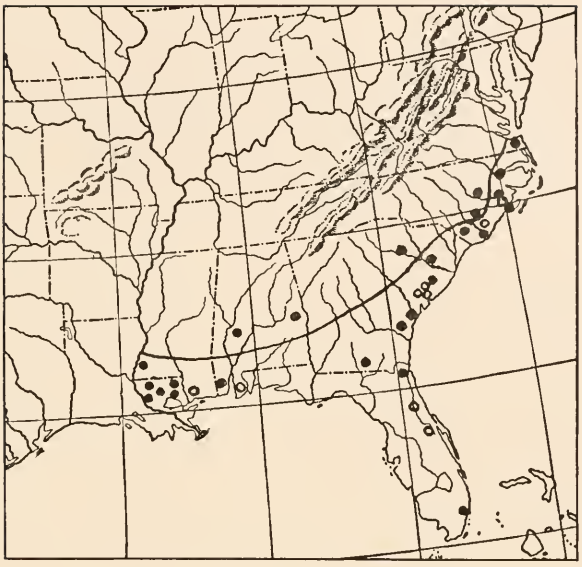
Type locality: Riceboro, Ga.

Range: From Dismal Swamp, Va., to Washington, Miss. Atlantic Coastal Plain.

Diagnosis: A *Desmognathus* with vomerine teeth absent in adult males; tail keeled above; belly mottled, dark; a row of light spots on sides.

Description: M. C. Z. No. 1070; adult female; Jacksonville, Fla.; 14 costal grooves; 5 costal folds between appressed toes; head width 6½ in length from snout to vent; head length 4 in length of body; head oval; eye as long as its distance from tip of snout; outline of upper jaw concave as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove cutting off front corner of upper eyelid; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 3, 4, 2, 5, 1 in order of length; lining of vent smooth; tail longer than body, circular in section at base, distally flattened, keeled and finned above; vomerine teeth 4 in series beginning behind inner end of nares, separated from its fellow by ½ the width of nares, and from parasphenoids by length of series; latter in two patches beginning at the anterior fourth of eyesocket; dark blackish brown, mottled with black above, slightly lighter below; on hinder half of body and on tail a row of light dots; a similar row between insertion of arm and leg; a light mark from eye to angle of jaw; total length 107, head 11, body 44, tail 52.

Variation: A male, same data, has head width 6; upper jaw very concave; tail shorter than body; papillae in vent; no vomerine teeth; premaxillary teeth enlarged and pointed; total length 104, head 14, body 48, tail 42.



5. South Atlantic and Gulf States, showing localities for Desmognathus fuscus auriculatus (south of line), and nearest localities for D. f. fuscus.

The vomerine series may be separated from the parasphenoids by twice the length of the series. 4 or 5 costal folds may separate the appressed toes. Specimens from the western part of the range are lighter in general coloration, thus approaching *brimleyorum*.

Measurements of a series follow (V. T. = vomerine teeth; C. F. = costal folds between appressed toes):

Specimen	*Sex*	*Length*	*Head*	*Body*	*Tail*	*V. T.*	*C. F.*	*Locality*
M. C. Z. 2783	Male	107	13	49	45	0	4½	Mobile, Ala.
M. C. Z. 1070	do	104	14	48	42	0	4½	Jacksonville, Fla.
U. S. N. M. 16675	do	86	11.5	43.5	32	0	4½	Clinton, La.
U. S. N. M. 21380	do	101	11.5	40.5	49	0	4½	Savannah, Ga.
U. S. N. M. 21379	do	90	11.5	38.5	40	0	4½	Do.
U. S. N. M. 11899	do	85	11	38	36	0	.....	Mobile, Ala.
U. S. N. M. 45920	do	101	12.5	37.5	51	0	.....	Washington, Miss.
U. S. N. M. 37086	do	100	12.5	35.5	53	0	4½	Wilmington, N. C.
M. C. Z. 1168	do	75	9.5	34.5	31	5-5	4	Beaufort, N. C.
U. S. N. M. 37085	do	78	9.5	31.5	37	4-5	4	Wilmington, N. C.
M. C. Z. 2783	do	85	8.5	31.5	45	4-3	4	Mobile, Ala.
U. S. N. M. 37084	do	74	10	29	35	4-5	4	Wilmington, N. C.
M. C. Z. 1168	do	69	8.5	30.5	30	5-4	4½	Beaufort, N. C.
Do.	do	60	8	27	25	3-4	4½	Do.
M. C. Z. 1070	Female	99	11	45	43	6-4	4	Jacksonville, Fla.
M. C. Z. 2783	do	89	11	42	36	3-5	4½	Mobile, Ala.
M. C. Z. 1070	do	107	11	44	52	4-4	5	Jacksonville, Fla.

Habits: Lönnberg (1894) says that he found one in Florida "under a log in a wet hammock."

Remarks: It definitely intergrades with *fuscus*, as has already been set forth. The approach to *brimleyorum* is clearly seen in specimens from Alabama and Louisiana. The form is best developed in Georgia and Florida. The specimen from Miami is perhaps incorrectly so recorded.

Specimens seen 100, as follows:

Virginia: Lake Drummond 1.

North Carolina: Grimesland 2 (M. C. Z. No. 5934-5); Beaufort 11 (M. C. Z. No. 1168, 4657-8); Newberne 1 (M. C. Z. No. 1884); Lake Waccamaw 5 (A. N. S.); Wilmington 3 (U. S. N. M. No. 37084-6).

South Carolina: Manning 2 (A. N. S.); Oakley 1 (U. S. N. M. No. 8906); no locality 2 (A. N. S.).

Georgia: Savannah 2 (U. S. N. M. No. 21379-80); Riceboro 12 (U. S. N. M. No. 3901 TYPES); Nashville 1 (U. S. N. M. No. 11899); no locality 14 (A. N. S.).

Florida: Jacksonville 3 (M. C. Z. No. 1070); Green Cove Springs 2 (Cornell); Esmeralda, Lake Co. 6 (U. S. N. M. No. 69857-62); Miami 1 (A. N. S.).

Alabama: Coden 1 (U. S. N. M. No. 19483); Mobile 3 (M. C. Z. No. 2783, 4746-7).

Mississippi: Washington 1 (U. S. N. M. No. 45920); no locality 2 (U. S. N. M. No. 3763, 3891).

Louisiana: 10 miles west Bogalusa 1 (Viosca); Independence 1 (Viosca); Covington 13 (Viosca, U. S. N. M.); Mandeville 4 (Viosca, U. S. N. M. No. 8874); Clinton 1 (U. S. N. M. No. 16675); Indian Mound 1 (Viosca).

It has also been recorded from:

Lake Ellis, N. C. (Brimley 1909); Willard, Pender Co., N. C. (Brimley 1925); Otranto, Mt. Pleasant, and Summerville, S. C. (Schmidt 1924); Hastings, Fla. (Brimley 1910); Lake Jessup, Orange Co., Fla. (Lönnberg 1894); Baldwin Co., Ala. (Löding 1922); Bay St. Louis, Miss. (Brimley 1910).

DESMOGNATHUS FUSCUS BRIMLEYORUM (STEJNEGER)

1895 *Desmognathus brimleyorum* Stejneger, Proc. U. S. Nat. Mus. 17, p. 598; Whipple 1906, Biol. Bull. 10, p. 263, ff. 5-6 (ypsiloid); Strecker 1908, Proc. Biol. Soc. Washington 21, p. 88 (habits); Hurter and Strecker 1909, Trans. Acad. Sci. St. Louis 18, 2, p. 11; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 22; Dunn 1917, Proc. U. S. Nat. Mus. 53, p. 414; Stejneger and Barbour 1917, Check List, p. 22; Dunn 1918, Bull. Mus. Comp. Zoöl. 62, p. 464; Stejneger and Barbour 1923, Check List (2), p. 19.

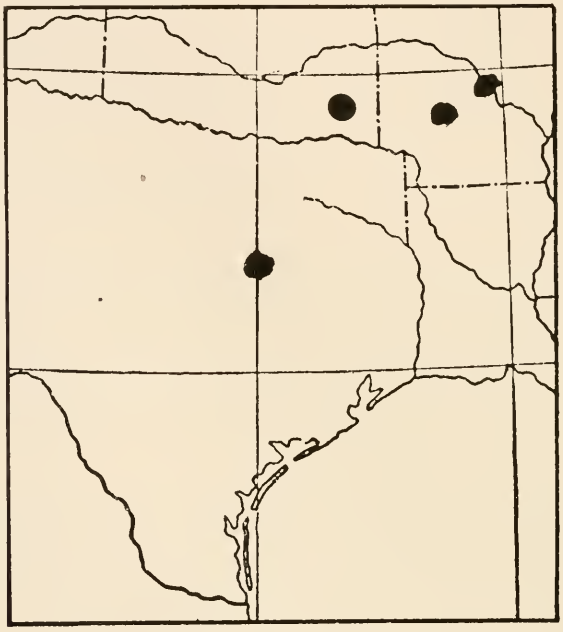
Type: U. S. N. M. No. 22157, collected by B. L. Combs in 1894.

Type locality: Hot Springs, Arkansas.

Range: Known only from Hot Springs and Little Rock, Ark., Waco, Texas, and Broken Bow, Oklahoma. Western part of Atlantic Coastal Plain.

Diagnosis: A *Desmognathus* with vomerine teeth lacking in adult males; tail keeled above; belly mottled, pale; a row of light spots on sides.

Description: M. C. Z. No. 2429, adult female; Little Rock, Ark.; 14



6. Part of Texas and Arkansas, showing localities for Desmognathus fuscus brimleyorum.

costal grooves, 4 costal folds between appressed toes; head width 5½ in length from snout to vent; head length 3 in length of body; head oval; eye shorter than its distance from tip of snout; outline of upper jaw slightly concave; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove cutting off front corner of upper eyelid; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1

in order of length; toes 3, 4, 2, 5, 1 in order of length; lining of vent smooth; tail longer than body, flat almost from base, keeled and finned above; vomerine teeth 9 in series, beginning behind inner edge of nares, separated from its fellow by width of nares and from parasphenoids by length of series; latter in two patches beginning opposite middle of eyesocket; mottled gray and brown above, light with gray mottling below; a light line from eye to angle of jaw; light spots with black borders in a lateral line from middle of body onto base of tail; total length 113, head 14, body 45, tail 54.

Variation: A male, M. C. Z. No. 4549, Little Rock, Ark., has 5 costal folds between appressed toes; outline of upper jaw sinuous; vent lined with papillae; tail shorter than body; no vomerine teeth; premaxillary teeth enlarged and sharpened; darker in all respects than described female, but general markings similar; total length 132, head 17, body 62, tail 53.

Some of the specimens, such as M. C. Z. No. 4957, a female from Little Rock, have 15 costal grooves. This specimen has 5 costal folds between the appressed toes.

The parasphenoid series are long and narrow in small specimens; in adults they are usually short and thick and sometimes confluent anteriorly. Males lose the vomerines at a length of about 95 mm.

The tail is like that of *fuscus,* but flatter and more finned above. It is always a good deal shorter than the head and body. The head length is from 3 to 4½ in the length of the head and body.

The absence of the gular fold and the grooves of the face in the type series was due to poor preservation.

Measurements of a series (V. T. = vomerine teeth; C. F. = costal folds between appressed toes):

Specimen	*Sex*	*Length*	*Head*	*Body*	*Tail*	*V. T.*	*C. F.*	*Locality*
M. C. Z. 2784	Male	134	17	65	52	0	5	Little Rock, Ark.
U. S. N. M.	do	128	16	58	54	0	4½	Do.
M. C. Z. 2784	do	122	16	51	55	0	4½	Do.
M. C. Z. 2539	do	99	14	48	37	0	4½	Hot Springs, Ark.
U. S. N. M.	do	113	15	48	50	0	.....	Little Rock, Ark.
M. C. Z. 2784	do	111	14	46	51	0	4½	Hot Springs, Ark.
U. S. N. M. 22169	do	93	.....	54	39	1	.....	Do.
U. S. N. M. 38796	do	93	11	40	42	4-4	3	Little Rock, Ark.
A. M. 506	Female	129	14.5	56.5	58	5-5	4½	Hot Springs, Ark.
A. N. S. 15785	do	118	14	51	53	4-3	4	Little Rock, Ark.
M. C. Z. 2429	do	113	14	45	54	9-9	4	Do.
U. S. N. M. 22165	do	105	13	50	41	.....	.....	Hot Springs, Ark.
U. S. N. M. 38797	do	105	12.5	44.5	48	5-7	4½	Do.
M. C. Z. 3142	do	101	13	43	45	4-4	4½	Little Rock, Ark.
U. S. N. M. 22161	do	93	12	43	38	.....	.....	Hot Springs, Ark.
U. S. N. M. 22163	do	95	12	42	41	.....	4½	Do.
M. C. Z. 2784	do	76	10	42	34	3-4	3	Little Rock, Ark.
U. S. N. M.	do	93	11.5	41.5	40	7-7	.....	Do.
U. S. N. M. 38798	do	80	10	34	36	6-6	4	Do.
U. S. N. M. 38799	do	64	9.5	28.5	26	3-4	4	Do.
M. C. Z. 2784	do	60	8	28	24	5-5	3	Do.
U. S. N. M. 38800	.....	59	8.5	27.5	23	7-6	3½	Do.
U. S. N. M.	.....	48	8.5	26.5	14	.....	.....	Do.
M. C. Z. 2784	.....	57	8	25	25	.....	4	Hot Springs, Ark.
U. S. N. M. 38801	.....	42	7	20	15	.....	3	Little Rock, Ark.

Habits: Strecker (1908) gives an account of the habits, taken chiefly from the field notes of B. L. Combs, who first collected them: "Comb's first specimens were found under the edges of flat rocks in the middle of a rather sluggish stream. Afterwards others were found under planks, logs and rocks, in damp woods in close proximity to water." They "would run at the slightest alarm." "In the latter part of August or early in September the female Triton deposits her eggs, which are from 30 to 36 in number, and attached together in strings, in a crevice in the under side of a rotten log, or in a mass of decaying wood near some small stream. The eggs are about an eighth of an inch in diameter. The female is much attached to her eggs and seldom goes far away from them. During a dry spell she will carry them down into her hole with her, and if it rains again before they are hatched will bring them again to the surface."

Hurter and Strecker (1909) speak of *brimleyorum* eating specimens of *Eurycea multiplicata* with which they were confined.

Remarks: Despite the large size, light belly, and finned tail, this form is probably more closely allied to *auriculatus* than to any other species. They are the two slimmest forms with the weakest limbs, and the only two forms which have the lateral row of light spots. The geographical arrangement also points to this relationship. The *auriculatus* from the Mississippi valley are a good deal lighter than those from the region of Georgia and Florida, thus approaching *brimleyorum*. The two probably have adjoining ranges and intergrade.

Specimens seen 103, as follows:

Texas: Waco 1 (Field Mus.).

Arkansas: Little Rock 21 (M. C. Z. No. 3142, 4547-50, 2429, 4954-8, U. S. N. M. No. 38797, A. N. S. No. 15785, Field); Hot Springs 28 (M. C. Z. No. 2598, 2537, 2784, U. S. N. M. No. 22157 TYPE, 22158-71, 38796, 38798-801, S. C. No. 1220, A. M. N. H. No. 556); no locality 1 (Cornell).

Oklahoma: McCurtain Co., 10 mi. S. W. Broken Bow 52 (U. Okla.); ½ mi. W. Broken Bow 1 (U. Okla.).

DESMOGNATHUS FUSCUS CAROLINENSIS (DUNN)

1870 *Desmognathus ochrophaea* Cope, Amer. Nat. 4, p. 396; 1889, Bull. U. S. Nat. Mus. 34, p. 194; Brimley 1907, Journ. Elisha Mitchell Sci. Soc. 23, 4, p. 154; 1912, Proc. Biol. Soc. Washington 25, p. 136; 1915, Journ. Elisha Mitchell Sci. Soc. 30, 4, p. 4.

1916 *Desmognathus ochrophaea carolinensis* Dunn, Proc. Biol. Soc. Washington 29, p. 74; 1917, Proc. U. S. Nat. Mus. 53, p. 417; 1917, Bull. Amer. Mus. Nat. Hist. 37, p. 609, pl. 58, ff. 6-9; 1918, Bull. Mus. Comp. Zoöl. 62, p. 464.

1917 *Desmognathus ochrophaeus carolinensis* Stejneger and Barbour, Check List, p. 23; Dunn 1920, Proc. Biol. Soc. Washington, 33, p. 132; Stejneger and Barbour 1923, Check List (2), p. 19; Breder and Breder 1923, Zoologica 4, 1, p. 17; Bishop 1924, Bull. New York Mus. 253, p. 92, pl. 3, f. 4; 1925, Copeia 139, p. 12.

1924 *Desmognathus fuscus carolinensis* Pope, Amer. Mus. Nov. 153, p. 4.

Type: U. S. N. M. No. 31135, collected by Brimley and Sherman, Oct. 5, 1902.

Type locality: Spring near top of Mt. Mitchell, N. C., "over 6,500 feet."

Range: From Beverly, West Virginia, south in the mountains to Gwinnett Co., Ga. Blue Ridge, southern section; Appalachian Valley, middle section; Allegheny Plateau, Kanawha section.

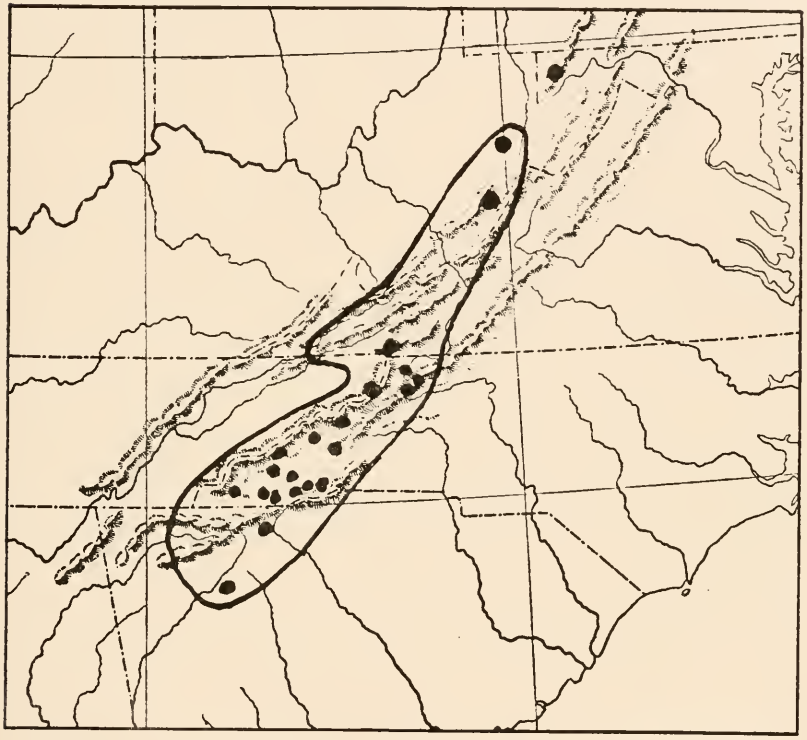
Diagnosis: A *Desmognathus* lacking vomerine teeth in the adult male; tail not keeled above, terete; belly mottled, dark; male with tendency to partly edentulous mandible; a groove across front corner of upper eyelid.

Description: Adult male, my own collection; Heywood Co., N. C.; 14 costal grooves; 3 costal folds between appressed toes; head width 5½ in length from snout to vent; head length 3 7/9 in length of body; head oval; eye shorter than its distance from tip of snout; outline of upper jaw sinuous; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove cutting off front corner of upper eyelid; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 2, 5, 1 in order of length; vent papillate; tail terete; no vomerine teeth; parasphenoids in two patches beginning behind eyesocket; teeth on mandible to middle of eye; premaxillary teeth enlarged and pointed; black, lighter below; a light mark from eye to angle of jaw; total length 82, head 9, body 34, tail 39.

Variation: A female, same data; has jaw slightly sinuous; premaxillary teeth like maxillary teeth; no papillae in vent; vomerine teeth in series of 6, beginning behind inner edge of nares, separated by twice width of nares and from parasphenoids by three times width of nares; latter in two patches beginning at middle of eyesocket; sides

black, a light dorsal band, below gray; total length 60, head 8, body 31, tail 21.

The color is variable. Old specimens are uniformly purplish black. Some specimens have an immaculate dorsal band, as in *ochrophaeus*, which may be red or yellow. Others have a zigzag dorsal band, or



7. Southern Appalachians, showing localities for Desmognathus fuscus carolinensis (outlined), and nearest localities for D. f. ochrophaeus.

even a series of paired dorsal spots. The sides of the tail are black as in *ochrophaeus*.

Bishop describes larvae from 5,500 feet on Mt. Mitchell as follows:

"Ten larvae have an average length of 18.6 mm. but vary from 15 to 23 mm. In spite of the difference in size, the specimens were prob-

ably of the same age when taken, for gill reduction had advanced to the same degree in all. Some individuals in color and markings are remarkably like larvae of *Desmognathus fuscus* of the same size, but others, even in this early stage, give intimation of the variability of markings found in the adults. Thus the dorsal unpigmented light areas may either be separated to form two distinct rows or coalesced with the median dorsal line to form a single, broad band with irregular edges; in other individuals the light areas unite with a very narrow median line to form a series of short cross bands connected in a chain-like pattern and margined along the sides by black. The light areas are sometimes opposite, more often alternating and united in a zigzag band.

"The sides of the body and tail and the legs above are rather uniformly mottled with pigment, the interspaces being dull yellow. The lower half of the sides in some specimens, however, is more strongly pigmented and in strong contrast with the immaculate venter. The tail above, particularly the distal half, is slightly keeled as in larvae of *D. fuscus*. There are no striking differences in the body proportions of the larvae of this species and of *D. fuscus* but the head seems to be somewhat broader in the latter. Where the ranges of the two species overlap, it may be impossible to separate the young larvae except by the amount of the gill reduction for a given size. In the larvae here considered the gills are reduced to short stubs which are pigmented and bear two or three unpigmented terminal filaments."

Measurements of a series follow: (C. F. = costal folds between appressed toes; V. T. = vomerine teeth).

The two largest are unusual, for out of 213 collected in 1916, the largest was 96 mm. long.

Specimen	*Sex*	*Length*	*Head*	*Body*	*Tail*	*V. T.*	*C. F.*	*Locality*
U. S. N. M. 31150	Male	113	11	43	59	0	4	Mount Mitchell, N. C.
U. S. N. M. 31135	do	102	11.5	40.5	50	0	4	Do.
E. R. D.	do	80	9	34	.....	0	4	Haywood Co., N. C.
Do.	do	82	9.5	33.5	39	0	3	Do.
Do.	do	78	9	33	36	0	4½	Do.
Do.	do	77	9.5	31.5	35	0	4	Do.
Do.	do	67	10	31	26	0	4	Do.
Do.	do	76	11.5	29.5	35	0	4	Do.
Do.	do	57	8	28	21	0	4	Do.
Do.	do	72	9	27	36	4-4	4	Do.
Do.	do	58	7	26	25	4-2	4	Do.
Do.	do	66	8.5	25.5	32	0	4	Cane River, N. C.
Do.	do	64	8	24	32	4-4	4	Mount Mitchell, N. C.
U. S. N. M. 31137	do	65	8	24	32	4-4	3	Do.
U. S. N. M. 31136	Female	82	10	33	39	4-4	4	Do.
E. R. D.	do	60	8	31	21	6-6	4	Haywood Co., N. C.
Do.	do	71	8.5	27.5	35	6-6	4	Do.
Do.	do	65	8	23	34	3-3	4	Cane River, N. C.
U. S. N. M. 31138	do	59	7.5	21.5	29	6-6	4	Mount Mitchell, N. C.
U. S. N. M. 31133	.....	51	7	22	22	.....	.....	Do.
U. S. N. M. 31134	.....	44	6	18	20	.....	.....	Do.

Habits: The habits are somewhat different in the case of the animals from the French Broad Valley, where intergradation with *fuscus* occurs, and in the case of the animals from higher in the mountains where the typical *carolinensis* is met. In the lower country the habits are quite like those of *fuscus*. In the mountains they are normally found in the same habitats as the Plethodons, and would seem as terrestrial as they were it not that occasionally one is found in or near a small stream. At Linville, where the typical form is found, they were everywhere from under a rock in water to under bark of a tree five feet from the ground, but by far the greater number were under logs on the ground.

I found eggs of the intermediate form at Brevard, July 21, and of the typical form in the Pisgah Forest Reserve, July 31. The altitude of the former locality is 2,300 feet, of the latter 3,500. Females were guarding both batches, and both were in rotten logs on the banks of a stream. They were of 10-15 eggs.

Bishop found larvae at 5,500 feet on Mt. Mitchell "on the wet sand beneath a large flat stone by the side of a small spring run."

Pope's specimens from Flat Rock are intergrades and the following accounts of their habits must be read with that in mind. His collection contained a few of the typical form from Linville, but none of his observations apply to it.

"In all the shaded brooks about Flat Rock this species was abundant. In the rocky hill-streams females with eggs were found, but only in small numbers. In such places the eggs were deposited at varying depths in the dead leaves, mud, and among rocks above, or just beside, flowing water. Immediately northeast of Trenholm Mountain in a thick, level woods, two or three small spring-streams or brooklets meandered along, spreading at places to some width. The resulting boggy, mossy area swarmed with brooding salamanders. Working alone in these woods on the afternoon of August twenty-first, the author secured fifty-nine egg-clusters, taking an adult with nearly every cluster. Not more than one hundred yards of stream-bed were covered. At its widest section, this particular brooklet spreads out to a width of fifty feet. This gives some idea of the abundance of the species in a favorable locality. Moss grows to a thickness of from one to three inches over roots and decaying wood in and along the bed of these brooklets. It is in this moss that the females congregate to de-

posit their eggs. They pick out preferably a well-covered log actually lying in the brooklet. In one such log described under *D. phoca,* eight clusters of *D. fuscus carolinensis* eggs, and one cluster of *D. phoca* eggs, were found. These eight clusters were below the moss, i.e., between it and the decayed log beneath. Eggs are found in or just under the moss and always over or immediately beside flowing water. None were found more than two or three feet from flowing or seeping water. One large log lay almost parallel to the flowing water along the low bank. Although well covered with moss along its entire length, and nowhere more than three or four feet from flowing water, only at its lower tip, a few inches of which actually projected out over the brooklet, were egg clusters found. After stripping all of the log but these last few inches (which escaped notice), the author moved on, having found nothing. Returning later, purely by accident he saw the projecting tip still covered with its small patch of moss. There, directly over the water, and within a few inches of one another, several clusters with adults were found. This well illustrates their love for real proximity to water.

"A series of a hundred clusters were taken from two or three connected streams in the one locality. In practically every case adults were found with the eggs. The adults were shy and made off unless promptly secured. The mere uncovering of the adult and eggs did not generally suffice to start the former on the run, but any further annoyance did. With a few exceptions, the eggs formed one compact cluster. Some clusters were slightly scattered. The adult was usually coiled about the eggs. A cavity was very evident in the majority of cases. Wilder's comparison of the eggs of *D. fuscus* to a bunch of toy balloons may be used to great advantage here. The prevailing tendency is to join the eggs at one point, thus forming a spherical, compact mass. Sometimes there is an irregular stringing out along a very short, gelatinous cord and sometimes, though seldom, the eggs seem to be stuck or joined at random into an irregular mass or even two shapeless masses. A tiny root or small piece of bark often forms a base of attachment. A typical cluster may be rolled about or dropped without coming apart. It is so compact that only a close examination reveals the way in which the bunch is held together.

"Data compiled from study of the series of 100 clusters, 92 of which are accompanied by their respective adults, are given below. Twenty-

three of these were found on August eighteenth, fifty-six on August twenty-first, and the rest on August twenty-third.

"Five of the clusters had larvae on the point of emerging; the larvae of fifty-five more clusters had distinct color patterns and were almost ready to emerge; the color patterns on the larvae of seventeen other clusters showed only faintly, while twenty-nine clusters had practically unpigmented but well advanced larvae. Eggs of the remaining four clusters were still in the cleavage and gastrula stages. That the average number of eggs found with one adult is 10.25 is shown by the following table:

2	clusters	had	4	eggs	each
2	"	"	5	"	"
3	"	"	6	"	"
8	"	"	7	"	"
7	"	"	8	"	"
16	"	"	9	"	"
18	"	"	10	"	"
16	"	"	11	"	"

13	clusters	had	12	eggs	each
4	"	"	13	"	"
2	"	"	14	"	"
3	"	"	15	"	"
3	"	"	16	"	"
2	"	"	17	"	"
1	cluster	"	18	"	

"The average might be raised a fraction to make allowance for the few eggs overlooked or lost.

"Formalin eggs in the cleavage and early gastrula stages are 3 mm. in diameter; those with embryos about to emerge, 4.5 mm., while just emerged embryos measure 15 mm., total length.

"Measurements of ten brooding adults taken at random (formalin specimens) follow:

Total Length	*Snout to Posterior Angle of Vent*
70 mm.	33.0 mm.
65 "	31.5 "
61 "	31.5 "
60 "	31.0 "
60 "	29.0 "
59 "	29.5 "
57 "	29.0 "
56 "	29.0 "
55 "	27.5 "
48 "	26.0 "

"Wilder states that *D. fuscus fuscus* from western Massachusetts examined by her ranged from 14 to 28 eggs for each female but averaged 20. In this respect, there is a marked difference between typical *fuscus* and *fuscus carolinensis*."

Remarks: Intergradation of this form with *fuscus* is definitely known to take place in the French Broad Valley, *fuscus* occurring at Asheville in a slightly dwarfed form. Flat Rock specimens have taken on the size, and to some extent the color and shape of tail of *carolinensis*. Brevard specimens have taken on the size and the shape of tail, but not altogether the color.

Whether intergradation occurs elsewhere is not known. On White Top, in Virginia, both *fuscus* and *carolinensis* occur in typical form. The same holds true for Mt. Sterling in the Smokies. The French Broad Valley is the only place so far known where there are actual intermediates and neither of the typical forms.

This situation excites speculation which would be scarcely profitable until the exact state of affairs in a number of places is known.

At any rate intergradation does occur and the typical forms are abundantly different. There seems to be no difference in breeding habits but a certain difference in habitat.

With *ochrophaeus* to the north the differences are of color, of amount of sexual dimorphism, and of the groove on the upper eyelid. In all three of these points *carolinensis* stands between *fuscus* and *ochrophaeus*. Maryland specimens are nearer typical *ochrophaeus*, West Virginia animals nearer typical *carolinensis*.

Specimens seen 436, as follows:

West Virginia: Rich Mt. near Beverly 1 (U. S. N. M. No. 33646); Big Spring Run 3 (U. S. N. M. No. 33627-9); Star Creek 1 (U. S. N. M. No. 33637).

Virginia: White Top Mt. 40 (M. C. Z. No. 7118-51).

North Carolina: Beaver Creek, Ashe Co. 29 (Breder); Hanging Rock Mt. 1 (N. Y. Mus.); Linville 159 (M. C. Z. No. 6416-38, A. M. N. H. No. 4525, 4573-98, 4672-5, 4721-64, 4765-7, 4943-5000); Roan Mt. 7 (A. N. S., U. S. N. M. No. 45520-4); Yancey Co. 1 (U. S. N. M. No. 31122); Bald and Sansom Mt., Yancey Co. (Field No. 1980); Cane River 10 (A. M. N. H. No. 677, E. R. D., Field 1979, U. S. N. M. No. 31143-4, 31146, 31149); Weaverville 2 (M. C. Z. No. 5936-7); Black Mts. 3 (M. C. Z. No. 1162); Mt. Mitchell 19 (Field No. 1978, E. R. D., U. S. N. M. No. 31129-30, 31133-4, 31135 TYPE, 31136-42, 31150-4); Blowing Rock 1 (U. Pa.); Henderson Co. 1 (A. N. S.); Blantyre 3 (M. C. Z. No. 2631, U. S. N. M. No. 38249, 38259); Brevard 49 (A. M. N. H. No. 4088-92, 4093-6, 4131-46, 4167, 4169, 4175, 4177-9, 4191, 4340, 4342, 4350-1, 4360-1, 4466, 4462, 4468-9, 4492-4, 4497, 4500, 4503, 4509); Pisgah Forest Reserve 27 (A. M. N. H. No. 4403-18, 4420-7, 4437, 4455-7); Bald Mt., Macon Co. 1 (M. C. Z. No. 2543); Wayah Bald Mt. 3 (U. S. N. M. No. 38252, 38256, 38261); Tatula Mt. 1 (U. S. N. M. No. 38258); Highlands 2 (U. S. N. M. No. 38255, 38257); Andrews 1 (U. S.

N. M. No. 38260); Haywood Co. 11 (E. R. D.); Mt. Sterling 16 (M. C. Z No. 6400-15).

Tennessee: Roan Mt. 7 (A. N. S.); Unaka Springs 1 (M. C. Z. No. 4482).

Georgia: Tallulah Falls 1 (Cornell); Gwinnett Co. 1 (U. S. N. M. No. 38550); no locality 7 (M. C. Z. No. 212, 4594-9).

It has also been recorded from Aquone and Sunburst (Brimley 1912); Oteen, Minehole Gap, Montreat, and Bridgewater (Bishop 1924); Flat Rock (Pope 1924); Linville Gap (Bishop 1925), all in North Carolina.

DESMOGNATHUS FUSCUS OCHROPHAEUS (COPE)

1859 *Desmognathus ochrophaea* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 124; 1869, id., p. 113; 1889, Bull. U. S. Nat. Mus. 34, p. 191, f. 47; Mearns 1898, Bull. Amer. Mus. Nat. Hist. 10, p. 303; Moore 1899, Proc. Acad. Nat. Sci. Philadelphia, p. 322 (lunglessness); Morse 1902, Ohio Nat. 2, p. 164; Britcher 1903, Proc. Onondaga Acad. Sci. 1, p. 121; Ditmars 1905, Amer. Mus. Journ. 5, 4, p. 177, f. 12; Stone 1906, Amer. Nat. 40, p. 162; Fowler and Dunn 1917, Proc. Acad. Sci. Philadelphia, p. 22.

1917 *Desmognathus ochrophaea ochrophaea* Dunn, Proc. N. S. Nat. Mus. 53, p. 415; 1918, Bull. Mus. Comp. Zoöl. 62, p. 464.

1882 *Desmognathus ochrophaeus* Boulenger, Cat. Batr. Grad. Brit. Mus. (2), p. 77; Bishop 1923, Copeia 118, p. 67.

1917 *Desmognathus ochrophaeus ochrophaeus* Stejneger and Barbour, Check List, p. 22; 1923, id., (2), p. 19; Bishop 1925, Copeia 139, p. 11.

1870 *Desmognathus haldemanni* Strauch, Mém. Acad. Sci. St. Pétersbourg (7), 14, p. 204.

1906 *Desmognathus fusca* Fowler, Proc. Acad. Nat. Sci. Philadelphia, p. 356, pl. 13, ff. 1-5.

Type: Destroyed.

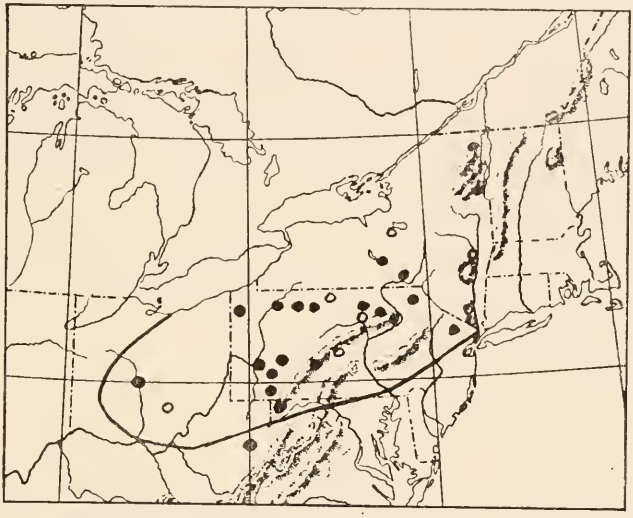
Type locality: Susquehanna Co., Pa.

Range: Clinton Co., New York to Garrett Co., Md., and to Columbus, Ohio. Allegheny Plateau, Connemaugh section, glaciated section, and Catskill section; Appalachian Valley, middle section; Adirondacks.

Diagnosis: A *Desmognathus* lacking vomerine teeth in the adult male; tail not keeled above, terete; belly mottled, pale; male with partly edentulous mandible, hinder teeth enlarged; no groove across front corner of upper eyelid.

Description: Adult male, in my own collection; Gold, Potter Co., Pa.; 14 costal grooves; 4 costal folds between appressed toes; head

width 6 in length from snout to vent; head length 3 in length of body; head oval; eye shorter than its distance from tip of snout; outline of upper jaw sinuous; angle of jaw back of hind angle of eye; both lids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 5, 2, 1 in order of length; vent papillate; tail imperfect, terete; no vomerine teeth; parasphenoids in two patches beginning at middle of eyesocket; premaxillary teeth enlarged, pointed; mandibular teeth to level of anterior corner of eye,



8. Northern Appalachians, showing localities for Desmognathus fuscus ochrophaeus (north of line), and nearest localities for D. f. carolinensis.

hinder teeth enlarged; dull brownish gray on sides of body; black on sides of tail; a lighter grayish brown dorsal band on body with a middorsal series of darker dots; gray below; a light mark from eye to angle of jaw; total length 75, head 11, body 35, tail 29.

Variation: A female, same data, differs as follows: head width 5⅔ in length from snout to vent; upper jaw not sinuous; no papillae in vent; vomerine teeth 4-5 in series, beginning behind inner edge of nares, separated from fellow by thrice width of nares and by the same

distance from parasphenoids; latter in two patches, beginning at front of eyesocket; mandibule fully toothed; mandibular and premaxillary teeth like maxillary; color same as described male, but lighter; total length 64, head 9, body 32, tail 24.

A young specimen, same data, has three costal folds between the appressed toes; an immaculate yellow dorsal band on body and on tail, bordered by a dark brown stripe, the upper edge of which is straight and definite and the lower edge of which enters into the general mottling of the sides; top of head dark; belly light; a light mark from eye to angle of jaw; total length 34, head 5, body 15, tail 14.

The groove across the upper eyelid is present in four specimens from Shokan, N. Y.

The color of this form is very constant. The belly is always light. The dorsal surface in old and large specimens is black. In all specimens in which the markings can be made out the dorsal surface is very light and there is a very dark, broad lateral band. The upper edge of this lateral band is straight and definite. The lower edge is indefinite, as the band gradually merges into the pale color of the ventral surface. Sometimes there are a few small spots along the mid-dorsal line, in medium and in large specimens. Young specimens have the dorsal area immaculate and it may be either pink or yellow. There is never any trace of the dorsal spots so conspicuous in the young of the other forms. The black lateral band extends the length of the tail as does the light dorsal band and the color of the tail is quite as characteristic of this species as is the shape of the tail.

The males lose the vomerine teeth at a length of 65-75 mm. Females the same size have developed eggs, which number according to Cope, 6-10 in each oviduct, and according to an observation on a large female from Potter Co., Pa., 10-14 in each oviduct. This might be compared with the average of 10 eggs per female which Pope found in *carolinensis;* Combs' statement that *brimleyorum* has 30-36; Mrs. Wilder's average of 20 eggs per female of *fuscus* in Western Massachusetts; Cope's average of 36-60 for *fuscus;* and my own findings on *fuscus* from Pennsylvania, small females having 28 eggs, and large ones 40. I am inclined to think that counts of number of eggs based on ovarian eggs are too large, and scarcely comparable with batches, so that the numbers of Pope and Combs, which deal with batches, had best not be too closely compared with mine, Mrs. Wilder's and Cope's,

which deal with ovarian counts. The number of eggs is directly relative to the size of the animal. *Ochrophaeus* and *carolinensis* are about the same size, and should have the same number.

Measurements of a series follow: (All are from Gold, Potter Co., Pa., in my own collection. C. F. = costal folds between appressed toes; V. T. = vomerine teeth).

Sex	*Length*	*Head*	*Body*	*Tail*	*V. T.*	*C. F.*
Male	90	10.5	37.5	43	0	4
do	94	10.5	36.5	48	0	4
do	87	10	35	42	0	3½
do	65	10	34	21	0	4
do	85	10	33	42	0	4
do	81	10	33	38	0	4
do	92	10	31	51	0	4
do	69	7.5	30.5	31	4-4	4
do	71	9	29	31	2-1	4
do	65	8.5	28.5	28	0	4
do	45	9.5	27	8.5	3-2	4
Female	87	9.5	33.5	44	3-3	4
do	83	9	32	42	3-4	3½
do	84	9	32	43	3-3	4
do	87	9.5	32	44	3-3	4
do	73	9	31	33	4-5	4
do	75	8	30	37	3-3	4
do	79	9	30	40	5-5	3½
do	72	9	29	34	6-4	3
do	61	8.5	27.5	26	3-3	3
do	68	7.5	26.5	34	4-4	4
do	67	8	26	33	4-4	4
do	68	9	26	33	4-4	.....
do	42	6	19	17	.....	4
do	35	5	15	15	.....	.....
do	31	5	15	11	.....	3

Habits: Cope (1889) claims that *ochrophaeus* is strictly terrestrial, being found "under the bark of every fallen log of hemlock *(Abies canadensis)* and in the débris of the dark, damp forests of the North. I never saw one in the water of streams and river banks, the habitat of the other species of the genus."

Fowler (1906) says of a collection from Potter and McKean Counties, Pa., which contained 308 *ochrophaeus* and 8 *fuscus*, "found every-

where in the valleys, about and in streams, and on the comparatively dry mountain tops, though there less numerous and more solitary."

No differences in breeding habits have been reported. Bishop (1925) took a female with eggs at Troy, Pa., on Aug. 3rd. The habitat relationships sound quite similar to those of *carolinensis*.

Remarks: This form is most closely related to *carolinensis*, from which it differs in lacking the groove across the upper eyelid; in constantly having a light, straight-edged dorsal band; and in greater degree of sexual dimorphism, especially in the mandibular dentition of the male. In these three characters *carolinensis* is more primitive and closer to *fuscus*, and *ochrophaeus* is more specialized and further from *fuscus*. The two agree in size, and in the shape of the tail.

I have seen no intergrades between this and *fuscus*.

Under the circumstances I am compelled to give this animal racial recognition, based *not* on observed differences in habits or in habitat, but on fairly constant anatomical differences from *fuscus*, and on anatomical resemblance to *carolinensis*, which is anatomically intermediate, and intergrades with both. I have observed habitat differences between *carolinensis* and *fuscus*, and the same differences have been reported between *ochrophaeus* and *fuscus*.

It is only fair to add that northern *fuscus* and southern *fuscus* differ, the northern specimens being smaller and more constant in coloration than the southern; and that this difference in coloration is of the same nature and in the same direction as the difference in coloration between *carolinensis* and *ochrophaeus;* it is not, however, sufficient to mask the great difference in color between the young of northern *fuscus*, in which a pattern of partially coalesced dorsal spots can always be seen, and the young of *ochrophaeus* in which no such pattern is at all visible.

Fowler (1906) gives figures of the young of *ochrophaeus*, which well illustrates this unique coloration. His uppermost five figures are *ochrophaeus*, his lowest, apparently, is a specimen of *fuscus*.

There is no evidence that this form occurs at all to the east of the Hudson-Champlain Valley. No specimens have been seen from New England, and this would appear to bear out my opinion that *ochrophaeus* is *not* a local modification of northern *fuscus*, but a northern derivative of *carolinensis*, and quite independent of *fuscus*.

The Ohio records may be erroneous, the Indiana one surely is.

Specimens seen 605, as follows:

New York: Clinton Co. 6 (A. N. S.); Westport 4 (U. S. N. M. No. 3915); Catskills 1 (U. S. N. M. No. 23192); Haines Falls, Catskills 12 (A. N. S.); Woodstock 1 (U. S. N. M.); Rockland Co. 1 (N. Y. Mus.); Shokan 4 (A. M. N. H. No. 422-4, 429); Ithaca 28 (M. C. Z. No. 3158, 3163, 4525-7, Cornell); Berkshire 3 (M. C. Z. No. 4591-3); Allegany Co. 5 (U. S. N. M. No. 3917); Hamburg 8 (Cornell).

New Jersey: Greenwood Lake 1 (A. M. N. H.).

Pennsylvania: Susquehanna Co. 3 (A. N. S.); Harvey's Lake 4 (A. N. S.); Ganoga Lake 10 (A. N. S.); Eaglesmere 4 (A. N. S.); Potter Co., Gold 250 (M. C. Z. No. 4475-80, E. R. D., A. N. S.); Seven Bridges 2 (A. N. S.); Brooklyn 1 (A. N. S.); Port Allegheny 55 (A. N. S., U. S. N. M. No. 67107); Warren 8 (A. N. S., Carnegie No. 2760-5); Meadville 24 (U. S. N. M. No. 6891); Blair Co., Broad Top Mt. 3 (A. N. S.); Portage 12 (Carnegie No. 1211-22); Cambria Co., Cresson 41 (Carnegie No. 871-90, 1126-50, 1419-25); Summit 1 (Carnegie No. 1418); Indiana Co., Indiana 4 (A. N. S.); Two Lick Hills 3 (A. N. S.); Two Lick Creek 5 (A. N. S.); Westmoreland Co., Laughlintown 13 (Carn. No. 1414-5, 1427-34); Jennerstown 3 (Carn. No. 1404-6); Allegheny Co., Heights Run 1 (Carn. No. 778); Boston 37 (Carn. No. 851-3, 1276-1309); Ohiopyle 25 (Carn. No. 1366-90).

Maryland: Garrett Co. 2 (A. N. S.); Jennings 9 (A. N. S.).

Ohio: Columbus 4 (U. S. N. M. No. 3896).

It has also been recorded from Onondaga Co., N. Y. (Britcher 1903); Albany Co., N. Y. (Bishop 1923); Highland Falls, N. Y. (Mearns 1898); Pennsylvania: Huntington Co., Charteroak; Sullivan Co., Lincoln Falls, Hillsgrove; Tioga Co., Liberty, Blossburg; Lycoming Co., Loyalsock (Bishop 1925); Sugar Grove, Ohio (Morse 1902); Logansport, Ind. (Morse 1902).

LEUROGNATHUS MOORE

1899 *Leurognathus* Moore, Proc. Acad. Nat. Sci. Philadelphia, p. 315 (type *marmorata*).

Diagnosis: Tongue attached in front; premaxilla single, nasal spines fused, no fontanelle; maxilla normal; no prefrontals; internal naris a foramen between maxilla and prevomer; condyles stalked; adult without vomerine teeth; atlas with transverse collar; eyes functional; gills of larva without rami; no marked sexual dimorphism; tail not constricted at base; toes 4-5, free; no palmar tubercles; one species.

Range: Same as that of the type species.

LEUROGNATHUS MARMORATA MOORE

1899 *Leurognathus marmorata* Moore, Proc. Acad. Nat. Sci. Philadelphia, p. 316, pl. 14, ff. 1-10; 1900, id., p. 613 (vertebrae); Dunn 1917, Proc. U. S. Nat. Mus. 53, p. 420, ff. 5-8; 1917, Bull. Amer. Mus. Nat. Hist. 37, p. 611, pl. 59, f. 3 (larva); Stejneger and Barbour 1923, Check List (2), p. 20; Dunn 1924, Copeia 127, p. 31; Bishop 1924, New York Mus. Bull. 253, p. 94, pl. 3, ff. 1-2; Pope 1924, Amer. Mus. Nov. 153, p. 13, f. 2.

1907 *Leurognathus marmoratus* Brimley. Journ. Elisha Mitchell Sci. Soc. 23, 4, p. 154; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 21; Stejneger and Barbour 1917, Check List, p. 23.

Type: A. N. S. No. 19610, collected by Dr. J. P. Moore.

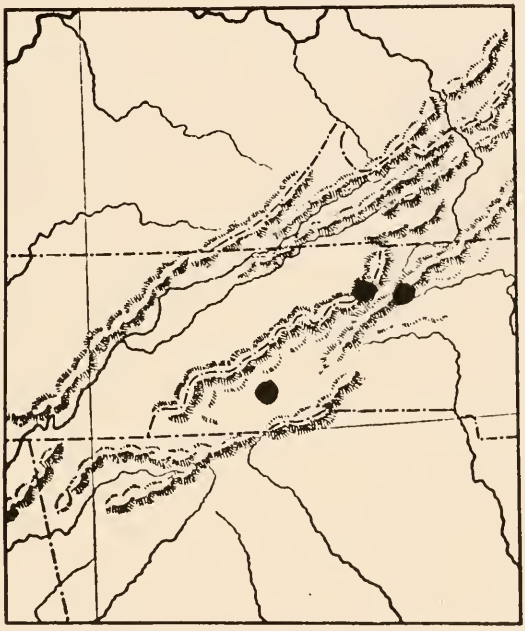
Type locality: Stream on south slope of Grandfather Mt., between Linville and Blowing Rock, N. C.

Range: Known only from Grandfather Mt., Roan Mt., and Waynesville, N. C. Southern Blue Ridge.

Diagnosis: A salamander with flattened, keeled, and finned tail; stout legs; very flat head; internal nares very small and twice as far apart as external nares; adult without vomerine teeth.

Description: A. N. S. No. 4383, Roan Mt., N. C.; adult male; 14 costal grooves; 3 costal folds between appressed toes; head width 5½ in length from snout to vent; head length 3⅓ in length of body; head a pointed oval; eye shorter than its distance from tip of snout; snout much flattened; outline of upper jaw sinuous as seen from side; angle of jaw back of hind angle of eye; upper eyelid fitting in a groove of lower behind, so that part of lower projects backwards spur fashion;

front corner of upper lid cut off by a groove; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers free, 3, 2, 4, 1 in order of length; toes free, 3, 4, 2, 5, 1 in order of length; tail shorter than body, square in section at base, trigonal and keeled above at middle, and much flattened and finned above and below at tip; anal lips lined with papillae; no vomerine teeth; parasphenoids in two patches the shape of a willow leaf, meeting in a point forwards, and diverging posteriorly, beginning opposite middle of eyesocket; black, soles of hand and foot and lips of vent white; head and lower lips brown; on each side of mid-dorsal line an obscure series of lighter blotches which extend on to the tail; total length 128, head 17, body 58, tail 53.



9. Western North Carolina, showing localities for Leurognathus marmorata.

Variation: A young specimen, from Waynesville, N. C., Smith College Collection, differs in having vomerine teeth in two small groups

of 3-4 teeth, between and slightly in advance of the nares, separated from each other by the length of the series, from the nares by twice that distance, and from the parasphenoids by 5 times that distance; dark, underside lighter; a double series of light dorsal spots, one to every other costal fold; white dots scattered over sides and top of head; a very distinct line of white-lipped pores along sides of belly from armpit to groin; total length 56; head 8, body 25, tail 23.

A larva, A. M. N. H. No. 4519, Pineola, N. C., has the tail longer than the body; almost uniform dark above, unpigmented below save for the chin; total length 63; head 8, body 24, tail 31. This differs from the larva of *Desmognathus quadra-maculatus* in its longer tail, shorter and slimmer head, slimmer body, pigmented chin, absence of light line from eye to angle of jaw, darker dorsal surface, and larger eyes wider separated. The head of a *quadra-maculatus* larva bears more resemblance to that of a pig, while this rather resembles a squid with its great staring eyes.

The smaller individuals have the belly quite light. Both sexes have the belly black when adult. The type series has 13 costal grooves and 2½ costal folds between the appressed toes.

Measurements of a series:

Specimen	*Sex*	*Length*	*Head*	*Body*	*Tail*	*V. T.*	*C. F.*	*Locality*
A. N. S. No. 4383	Male	128	17	58	53	0	3	Roan Mt.
U. Pa.	Female	120	15	54	51	0	2½	Blowing Rock
U. Pa.	do	117	15	.....	.....	0	2½	Grandfather Mt.
U. Pa.	do	108	14	41	31.5	0	2½	Do.
A. N. S. No. 19610	Male	98	13.5	46	41	0	2½	Do.
S. C.	young	56	8	25	23	3-4	3	Waynesville
A.M.N.H. No. 4519	larva	63	8	24	31	.....	.....	Pineola

Habits: Moore (1899) says of them "they seem to be essentially aquatic, remaining in the deeper parts of the pool and not burrowing beneath stones in places merely wet, as does the *D. nigra,* which occurs in great numbers in the same region. *L. marmorata* is much less active than the latter species and swims rather sluggishly, but with an easy gliding motion. The individuals seemed rather shy, and when alarmed quickly took refuge under the large rocks scattered through the pool, from beneath which, however, they were easily induced to emerge by the attraction of pieces of meat thrown into the water."

The larva I caught in Grandmother creek was swimming in the open water of a quite large stream.

The Waynesville specimen was taken in a sort of swampy or rocky spring in company with *D. fuscus* and *D. phoca,* and in a decidedly different situation from all the other specimens of known provenance.

Bishop (1924) gives the following account of the habits:

"The first specimen of this interesting species was revealed when Mrs. C. R. Crosby turned over a flat stone in the bottom of the small pool at the foot of a waterfall. Two other specimens were found in the same pool within a few minutes. The behavior of a specimen exposed to light by the removal of the stone under which it is hiding, is strikingly different from that of *Desmognathus quadra-maculatus* or *Desmognathus phoca* which may be living in the same stream.

"The highly protective color pattern of *Leurognathus,* which is of course effective only while the animal is motionless against a pool-bottom background of gravel or small stones, is doubtless responsible for its sluggishness. The pattern is essentially that of the darter and other small fish which forage over gravelly bottoms. When exposed by the turning of a stone, scarcely an attempt was made to escape and all specimens found were simply picked up by hand and transferred to the collecting bag. They could be induced to swim, but the process was a leisurely one and lacked entirely the vigor shown by *D. quadra-maculatus* or *D. phoca.*

"The first three specimens taken were found in the pool which, I believe, is the one that furnished Dr. J. Percy Moore with the specimens upon which he based the genus. Two other specimens were taken in a small stream on the southwestern side of Grandfather mountain. Here they were hiding under stones with *D. quadra-macu-*

latus but not in pools, probably because the protracted drouth had reduced their living quarters. Following the suggestion of Dr. E. R. Dunn, that the species is an inhabitant of large streams, I spent considerable time turning stones and examining possible hiding places, but without results. From my experience with *Leurognathus*, I am inclined to believe that it will be found in numbers in the streams of Grandfather mountain if the collector who seeks it will devote his time to the pools and not give too much attention to the capture of the ever-present and exceedingly active *Desmognathus quadra-maculatus*."

Pope (1924) collected more specimens than were previously known and found a batch of eggs. His observations follow:

"On August sixth we hunted in Boone Fork below the bridge and not far from the Finley Gragg house. During the day twenty-four adults, all but four more than 8 cm. long, were taken. Three larval and one transforming individual were also secured. The largest specimen is 12.5 cm. long.

"The first adult was seen resting on a stone in the main stream. When disturbed, it moved slowly away, a few feet at a time. All individuals moved in much the same deliberate way and seemed to be incapable of making the quicker movements that *quadramaculatus* makes. They were generally sighted among stones of the bed, often through two or three feet of crystal water. None were seen out of water. *D. quadramaculatus* was abundant among the stones strewn along the waters' edge but scarcer than *L. marmorata* in the main stream.

"*L. marmorata* is readily caught by either one of two methods. The first is to scan the bottom while slowly advancing against the current in the wider, smoother stretches of the stream. Likely stones should be carefully moved. The salamanders are readily sighted and at once distinguished by their coloration and deliberate locomotion. With a little trouble they may be coaxed into a net or even taken with the hands. Once or twice we were able, by removing obstructing rocks, to lower the water-level over a deeper stretch and thus bring hiding adults near the surface. This procedure enables one to get larvae and adults only. The second method must be resorted to when eggs are desired. A small "drop" should be found and a net placed immediately below so as to receive the rushing water. All stones about

and over which the water rushes should then be lifted out and examined. Adults will be washed into the nets. It is almost useless to hunt elsewhere for eggs in these high-altitude creeks.

"On August sixth a cluster of twenty-eight eggs was found attached to the edge of a stone measuring approximately 6 x 5 x 2 inches. This well-submerged stone was jammed deep among others over and about which the water poured. The eggs were grouped together in two layers, the lower having the greater number of eggs. A larva emerged from one of the fifteen that were put in formalin on the spot. Of the thirteen kept in moss, two emerged August eleventh, two more August twelfth, and five on August thirteenth. Six of the nine survived to be put in formalin August twenty-first. One of the six is shown in Fig. 2. No adult was taken and it cannot be proved beyond all doubt from material at hand that they are *marmorata* eggs. The emerged individuals differ greatly from *quadramaculatus* larvae of the same age: *phoca* was not found in the actual flow of water; while *marmorata* larvae and adults were abundant. In fact, the author cannot recall seeing more than one *phoca* in Boone Fork. From the striking similarity of this cluster to the *quadramaculatus* clusters, one is forced to conclude that the egg-laying habits of the two salamanders are the same. Measurements of formalin specimens are:

Length of longest attachment cable	3 mm.
Diameter of longest attachment cable	0.5 mm.
Diameter of well-advanced egg	5-6 mm.

In life of the eggs of *quadramaculatus* are noticeably larger than those of *marmorata*."

Remarks: This animal has had a peculiar history. First taken by Rhoads on Roan Mt. in 1895, and second by Moore in 1899 on Grandfather Mt., it was not collected again until 1916 when I took a larva near Pineola, and not after that until 1923 when Miss Rehm took a very young specimen at Waynesville, and Bishop collected five on Grandfather Mt. The two largest specimens of the first five taken had black bellies and were misidentified as *Desmognathus quadramaculatus*, so that Moore established genus and species on the three smallest of his collection of four. Bishop in 1923 and Pope in 1924 have finally discovered the true habitat of the form, and have found it common enough.

It is unquestionably nearest related to *Desmognathus quadra-*

maculatus, which it resembles closely in appearance and in breeding habits.

Its divergences from it are the change in position and in size of internal nares; the flattening of the skull; the closure of the premaxillary fontanelle; and the loss of the vomerines. These can all be considered as adaptations to aquatic life.

Specimens seen 35, as follows:

North Carolina: Roan Mt. 1 (A. N. S. No. 4383); Blowing Rock 1 (U. Pa.); Grandmother Creek, near Pineola 1 (A. M. N. H. No. 4519); stream on south side of Grandfather Mt., between Linville and Blowing Rock, about 10 miles from the latter 3 (U. Pa., A. N. S. No. 19610 TYPE); Boone Fork, on Grandfather Mt. 28 (A. M. N. H. No. 21128-51, 21153-6); 5 miles west of Waynesville 1 (S. C.).

It has also been recorded from another locality on the southwestern side of Grandfather Mt. (Bishop 1922).

PLETHODON TSCHUDI

1838 *Plethodon* Tschudi, Mém. Soc. Sci. Nat. Neuchâtel, p. 58 (type *glutinosus*).
1839 *Phatnomatorhina* Bibron in Bonaparte, Fauna Italica, Fsc. 26 (substitute name).
1843 *Sauropsis* Fitzinger, Syn. Rept., p. 33 (type *erythronotus*).

Diagnosis: Tongue attached in front; two premaxillae, nasal spines not fused, a fontanelle; septomaxilla present; maxilla normal; prefrontals present, bordering nares; internal naris a notch in prevomer; vomerine and parasphenoid series not continuous; condyles sessile; atlas normal; eyes functional; no aquatic larval stage; no marked sexual dimorphism; tail not constricted at base; toes 4-5, free or slightly webbed; terminal phalanges T-shaped; no palmar tubercles; 11 forms.

Range: New Brunswick to Florida, Texas, Missouri, Wisconsin and Ontario; British Columbia to California.

Key to forms of *Plethodon:*

A. Western species.
  B. Black below, 18 costal grooves, 6-7 costal folds between appressed toes . . . . . *elongatus* 156
  B B. Not black below, 16 or fewer costal grooves, 4 or fewer costal folds between appressed toes.
    C. 14-16 costal grooves, 2-4 costal folds between appressed toes, toes nearly free, 6-7 vomerine teeth . . . *intermedius* 154
    C C. 12-13 costal grooves, 0-1 costal folds between appressed toes, toes half webbed, 10 vomerine teeth . *vandykei* 151

A A. Eastern species.
  B. Small species, 16 or more costal grooves, 6 or more costal folds between appressed toes in adults; 7-5 vomerine teeth; usually a red dorsal stripe, belly mottled.
    C. Usually 16-18 costal grooves; zig-zag dorsal stripe; if stripe is absent, then light with dark spots on tail . . *dorsalis* 158
    C C. Usually 19-20 costal grooves; straight-edged dorsal stripe; if stripe is absent, then very dark above . . *cinereus* 163
  B B. Larger species, 17 or fewer costal grooves, 0-4 costal folds between appressed toes; 6-17 vomerine teeth; belly uniform.

C. 16-17 costal grooves, 6-9 vomerine teeth; white pigment spots, if present, in a band along sides; young sometimes with red dorsal spots, throat light . . . . . *wehrlei* 133

C C. 14-15 costal grooves.

D. White pigment spots usually present, vomerine teeth 17-11.

E. Appressed toes meeting, 17 vomerine teeth; white pigment spots in a band along sides; adult with a dull red dorsal band; young with paired dorsal red spots; throat light . . . . . *yonahlossee* 129

E E. Appressed toes separated by 3-4 costal folds; 11-13 vomerine teeth; white pigment spots generally distributed; adult without red markings; young usually without red markings; throat dark . . *glutinosus* 136

D D. White pigment spots absent; vomerine teeth 14-7, throat light.

E. Vomerine teeth more numerous; legs longer; black, a red patch on side of head . . . . . *jordani* 145

E E. Vomerine teeth less numerous; legs shorter; no red on head.

F. Black, legs red . . . . . *shermani* 146

F F. Gray, no red markings . . . . . *metcalfi* 148

Note: *Plethodon persimilis* Gray (1859, Proc. Zoöl. Soc. London, p. 230, pl. 19, f. 2) from Siam is really a species of *Ambystoma* closely related to *Ambystoma jeffersonianum*.

PLETHODON YONAHLOSSEE DUNN

1912 *Plethodon glutinosus* (var.) Brimley, Proc. Biol. Soc. Washington 25, p. 137.

1917 *Plethodon yonahlossee* Dunn, Bull. Amer. Mus. Nat. Hist. 37, p. 598, f. 1, pl. 57, ff. 1-3; Stejneger and Barbour 1917, Check List, p. 17; Dunn 1920, Proc. Biol. Soc. Washington 33, p. 130; Noble 1921, Bull. Amer. Mus. Nat. Hist. 44, p. 5 (skull); Stejneger and Barbour 1923, Check List (2), p. 12; Breder and Breder 1923, Zoologica 4, 1, p. 15.

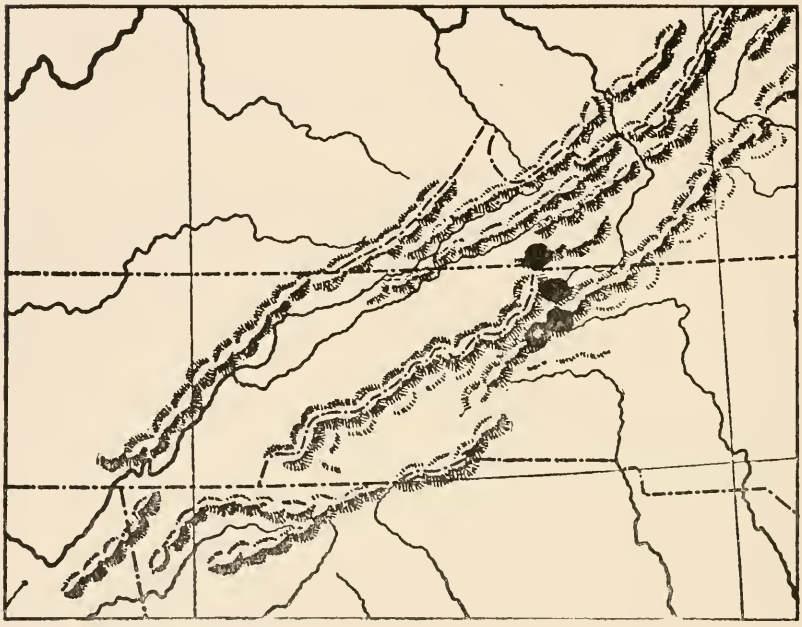
Type: A. M. N. H. No. 4634, collected by E. R. Dunn and W. S. Nevin, Aug. 16, 1916.

Type locality: near the Yonahlossee road about 1½ miles from Linville, N. C., altitude 4,200 feet.

Range: Northern half of Southern Blue Ridge. White Top Mt., Va., to Grandfather Mt., N. C.

Diagnosis: A large *Plethodon* with white pigment spots along sides, long vomerine series, 14 costal grooves, and a red dorsal stripe.

Description: M. C. Z. No. 6151, adult female, Grandfather Mt., N. C.; 14 costal grooves, appressed toes meeting; head width 5⅔ in length from snout to vent; head length 3¼ in length of body; head oval from above; eye as long as its distance from tip of snout; both eyelids fitting under a fold of skin behind; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; a



10. Southern mountains, showing localities for Plethodon yonahlossee.

groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length, slightly webbed at base; toes 3, 4, 2, 5, 1 in order of length, slightly webbed at base; tail terete, longer than body; vomerine teeth 17 in series, beginning beyond outer edges of nares, running in and back, separated from fellow by width of nares, and from parasphenoids by same distance; latter in two patches beginning opposite anterior ⅓

of eyesocket; black, lighter below, especially on throat and tail; a few scattered light spots on sides; in life with a red dorsal band from head to base of tail; total length 150, head 19, body 62, tail 69.

Variation: A young specimen, M. C. Z. No. 6155, White Top Mt., Va., has head length 2⅓ in length of body; white below; black above, mottled with white on sides from eye to leg; a dull red tinge on dorsal region from head to base of tail; five or six areas on each side of dorsum without black pigment; total length 60, head 9, body 21, tail 30.

The vomerine teeth usually extend further beyond the nares than the width of the nares, the series are separated by ⅕ their own length, and from the parasphenoids by ¼ their own length. The latter are confluent or separated by a narrow groove. The belly is uniform in color, lighter than that of *glutinosus* and darker than that of *metcalfi*. The whole surface is sprinkled with tiny unpigmented dots, but lacks the larger unpigmented spots which are irregularly scattered over the belly of *glutinosus*. The white pigment patches, overlying the black pigment, which this species, *glutinosus* and *werhlei* possess, are not present save on the sides and there rather crowded into a band of white. In the young the black pigment is absent in a double series of dorsal patches, 4-6 in each row. The red of the whole dorsal surface shows much more brightly in these patches. In adults the back is uniformly covered with black pigment, but the red is visible as a dark chestnut patch covering the whole back from the base of the head to the base of the tail. It extends on the sides only as far as a line between the bases of the legs, the space on the sides between the bases of the legs being almost covered by the white pigment spots. Both red and white pigment fade in preservation. The tail may be longer than the head and body. The head length may be 3½ in the length of body. In some adults the appressed toes are separated by 2 costal folds. The costal grooves are 14, not counting one above the arm or one which is a bifurcation of the last. The animal is much less slimy than *glutinosus*. It ranges in length from 47-165 mm. Specimens below 65 mm. have the light dorsal patches.

Measurements of a series from the type locality follow:

Length	*Head*	*Body*	*Tail*		
165	19.2	60.8	85	U. S. N. M. No. 36397	
140	19	58	63	Am. Mus. Type No. 4634	
142	17	55	72	"	
142	16	54	72	"	
133	16	52	65	"	
117	16	48	53	"	
126	16	50	60	"	
103	15	50	38	"	
95	14	46	35	"	
111	13.5	41.5	56	"	
103	13	40	50	"	
105	13.5	43.5	58	"	
116	13.5	41.5	61	"	
97	11	38	48	"	
92	13	36	43	"	
81	12	38	31	"	
83	10	33	40	"	
81	10	30	41	"	
62	8	25	29	"	Dorsal spots
42	9	26	5	"	"
61	8	23	30	"	"
58	7.5	23.5	27	"	"
57	8	23	26	"	"
57	7.5	22.5	27	"	"

Habits: The specimens of this rare form which have come to light were all taken in woods between 3,500 and 4,400 feet. There their habits are much the same as the more common *glutinosus*. They are extremely active, more so than the other *Plethodons* which I have seen. They have long burrows in the floor of the forest, whose openings are usually under a fallen log or piece of bark. Probably they pass the day in retirement, either in their burrows or at the mouth, and roam abroad at night. Occasionally they are found between bark and wood of some rotten log. When discovered near the mouth of a burrow they make for it with all speed.

It is much the rarest of the *Plethodons* which frequent the same woods. At White Top and at Linville I took about 7 *metcalfi* to one *yonahlossee,* and about 2 *glutinosus* or *cinereus* to one of the rarer form. And this is of course an understatement of its rarity, for much greater efforts were made to capture every specimen of *yonahlossee* that was seen than in the case of the commoner sorts.

Remarks: It is related to *glutinosus* and to *wehrlei*. It has a longer vomerine series than either of them, a more primitive coloration than either, and *wehrlei* is a more elongate form. It is probably the most primitive, not only of the three but of the whole genus *Plethodon*.

In coloration *wehrlei* resembles *yonahlossee* more than does *glutinosus* and is perhaps more directly derived from it. It occupies a separate range and appears to be a somewhat degenerate northern form.

Specimens seen 44, as follows:

Virginia: White Top Mt., 4,000 ft. 6 (M. C. Z. No. 6155-60).

North Carolina: Beaver Creek, Ashe Co., 3,500-4,000 ft. 5 (Breder); Grandfather Mt., Linville to Blowing Rock, 4,000-4,400 ft. 33 (U. S. N. M. No. 36397-8, M. C. Z. No. 6151-4, A. M. N. H. No. 4633-44, 4666-7, 4711-4, 4853-6).

Brimley in a letter tells me it has been taken at Linville Falls, Burke Co., N. C.

PLETHODON WEHRLEI FOWLER AND DUNN

1917 *Plethodon wehrlei* Fowler and Dunn, Proc. Acad. Nat. Sci. Philadelphia, p. 23, pl. 4; Stejneger and Barbour 1917, Check List, p. 17; 1923, id. (2), p. 12.

Type: A. N. S. No. 19123, collected by R. W. Wehrle, September, 1911.

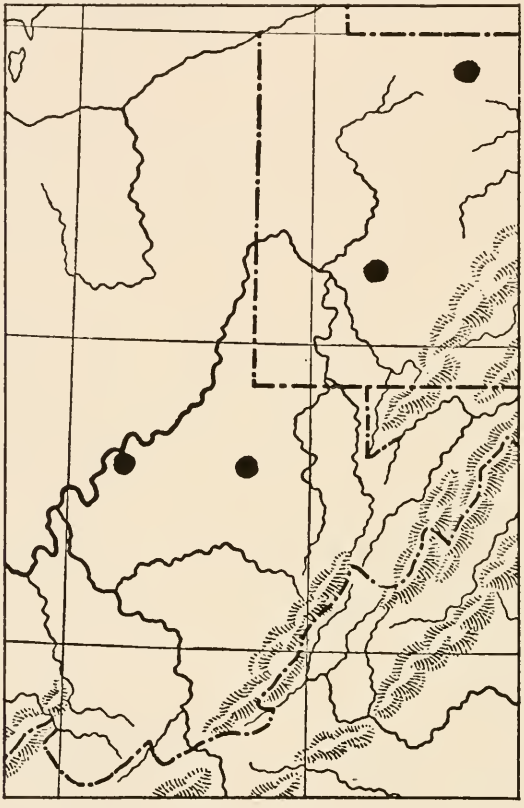
Type locality: Two Lick Hills, Indiana Co., Pa.

Range: Port Allegheny, McKean Co., Pa., to Bristol and Parkersburg, W. Va. Appalachian Plateau, northern section.

Diagnosis: A large *Plethodon* with 16-17 costal grooves; toes webbed at base; white pigment dots on sides; throat white; young with paired red spots on dorsum.

Description: M. C. Z. No. 7357, adult male; Bristol, W. Va.; 17 costal grooves; 2 costal folds between appressed limbs; head width 7⅓ in length of body; head length 4 in length of body; head a blunt oval from above; eye as long as its distance from tip of snout; snout slightly swollen; outline of upper jaw concave as seen from side; angle of jaws back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 4, 2, 1 in order of length, webbed at base; toes 4, 3, 2, 5, 1 in order of length, webbed at base; tail terete, longer than head and body; vent lined with papillae; vomerine teeth 6 in series beginning behind outer edge of

nares, running in and back, separated from its fellow by thrice the width of the nares, and from the parasphenoids by the same distance; latter in two patches beginning opposite middle of eyesocket; black, lighter below, white on throat; light dots scattered thickly on sides,



11. Northern Appalachians, showing localities for Plethodon wehrlei.

very few above and below; total length 126, head 12.5, body 50, tail 63.5.

Variation: A female, M. C. Z. No. 7361, same data, has 16 costal grooves; tail longer than body; no papillae in vent; vomerine teeth

9 in series, separated from its fellow by width of nares, and from the parasphenoids by the same distance; latter in a single patch; total length 125, head 13, body 52, tail 60.

A small one, M. C. Z. No. 7358, same data, has the appressed toes separated by one costal fold; the throat and chest are light, and there are two red spots on one side of the back and one on the other; total length 83, head 9.5, body 33, tail 40.5.

A. M. N. H. No. 15746, from Parkersburg, W. Va., is spotted on the belly, and the appressed toes are separated by three costal folds. In A. M. N. H. No. 15745, the appressed toes meet. In the type, A. N. S. No. 19123, a female 138 mm. long, the appressed toes are separated by 4½ costal folds. Thus the legs are longer in young specimens and shortest in adult females. The tail is shorter than the body in the smallest ones.

Measurements of a series:

						cg/cf	
A. M. N. H. No.	15746	♀	152	14	58	80	17/3	Parkersburg, W. Va.
"	15744	♀	127	14	51	62	17/3	"
"	15747	♀	67	13	46	8	17/2	"
"	15745	♀	53	9	30	14	17/0	"
M. C. Z. No.	7356	♀	113	14	56	43	17/3	Bristol, W. Va.
"	7360	...	114	13	52	49	17/2	"
"	7361	♀	125	13	52	60	16	"
"	7357	♂	126	12.5	50	63.5	17/2	"
"	7359	...	92	12	45	35	16	"
"	7358	...	83	9.5	33	40.5	17/1	"

The smallest of the original series was 44 mm. long.

Habits: Nothing is known of the habits except that they seem similar to those of *glutinosus*.

Remarks: This animal belongs to the *glutinosus* group of the genus, and is related to *glutinosus, yonahlossee* and *metcalfi*. It is probably most nearly allied to *yonahlossee* because of the presence of white pigment spots only on the sides, of the presence of red pigment on the dorsal surface, of the whiteness of the throat. It is the most elongate of the group. A. N. S. No. 4799, from Tuscarora, Juniata Co., Pa., which was mentioned in the original description, seems on second examination to be *glutinosus*.

Specimens seen 17, as follows:

Pennsylvania: Port Allegheny, McKean Co. 1 (A. N. S. No. 17231); Indiana 1

(A. N. S. No. 19066); Two Lick Hills, Indiana Co. 5 (A. N. S. No. 19114-5, 19118, 19123 TYPE, 19124).

West Virginia: Bristol 6 (M. C. Z. No. 7356-61); Parkersburg 4 (A. M. N. H. No. 15744-7).

PLETHODON GLUTINOSUS (GREEN)

1818 *Salamandra glutinosa* Green, Journ. Acad. Nat. Sci. Philadelphia 1, p. 357; Harlan 1826, same, 5, p. 330; Holbrook 1838, N. Amer. Herp. 2, p. 129, pl. 30; Storer 1839, Rept. Massachusetts, p. 252; Troost 1840, Geol. Rept. Tennessee 5, p. 39; Holbrook 1842, N. Amer. Herp. (2), 5, p. 39, pl. 10; DeKay 1842, Zoöl. New York 3, p. 81, pl. 17, f. 42; Thompson 1842, Hist. Vermont, p. 119; Linsley 1844, Amer. Journ. Sci. Arts 46, p. 50; Fogg 1862, Bull. Portland Soc. Nat. Hist. 1, p. 86; Provancher 1874-5, Nat. Canadien, 6-7.

1838 *Plethodon glutinosus* Tschudi Mém. Soc. Sci. Nat. Neuchâtel, p. 58; Fitzinger 1843, Syst. Rept., p. 34; Baird 1849, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 285; 1852, New York Mus. Rept., p. 21; Burnett 1852, Bull. Boston Soc. Nat. Hist. 4, p. 146; Matthes 1855, Allg. deutsche nat. Zeit. 1, p. 259; Hallowell 1856, Proc. Acad. Nat. Sci. Philadelphia, p. 11; 1858, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 342; Cope 1862, Proc. Acad. Nat. Sci. Philadelphia, p. 124; Putnam 1866, Proc. Bost. Soc. Nat. Hist. 10, p. 272; Allen 1868, same, 2, p. 198; Cope 1869, Proc. Acad. Nat. Sci. Philadelphia, p. 99; 1871, Rept. Peabody Acad. 1870, p. 84; Wiedersheim 1877, Morph. Jahrb. 3, pl. 21, f. 43, 49, pl. 23, f. 74, pl. 24, f. 81-2, 93, pl. 25, f. 96, 100, pl. 26, f. 116, 129 (skull); Cope 1880, Bull. U. S. Nat. Mus. 17, p. 30; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 56; Hoy 1883, Geol. Wisconsin 1, p. 426; Davis and Rice 1883, Bull. Chicago Acad. Sci. 1, 3, p. 27; Davis 1884, Proc. Nat. Sci. Ass. Staten I. 1, p. 13; Cope 1888, Journ. Morph. 2, p. 300, pl. 22, f. 14; 1889, Bull. U. S. Nat. Mus. 34, p. 139, f. 31, pl. 26, pl. 31, f. 6, pl. 35, f. 2, pl. 40, f. 4, pl. 45, f. 5, pl. 48, f. 14; Worthen 1891, Vert. Hanover, p. 61; Garman 1892, Bull. Illinois Lab. Nat. Hist. 3, p. 365; Cope 1892, Amer. Nat. 26, p. 965; Hay 1893, Rept. Indiana Geol. 17, p. 36; Higley 1893, Proc. Wisconsin Acad. Sci. 7, p. 172; Garman 1894, Bull. Essex Inst. 26, p. 38; Gaines 1895, Amer. Nat. 30, p. 55; Sherwood 1895, Proc. Linn. Soc. New York 7, p. 21; Rhoads 1895, Proc. Acad. Nat. Sci. Philadelphia, p. 401; Brimley 1896, Amer. Nat. 30, p. 500; Lönnberg 1896, Zoöl. Anz. 19, p. 34 (lunglessness); Cox 1898, Bull. Nat. Hist. Soc. New Brunswick 4, 16, p. 64; Mearns 1898, Bull. Amer. Mus. Nat. Hist. 10, p. 303; Beyer 1900, Proc. Louisiana Soc. Nat. 1897-9, 1, p. 10; Moore 1900, Proc. Acad. Nat. Sci. Philadelphia, p. 618 (vertebrae); Morse 1901, Ohio Nat. 1, p. 115; Hay 1902, Proc. Biol. Soc. Washington 15, p. 125; Britcher 1903, Proc. Onondaga Acad. Sci. 1, p. 120; Stone 1903, Proc. Acad. Nat. Sci. Philadelphia, p. 538; Henshaw 1904, Occ. Pap. Boston Soc. Nat. Hist. 7, 2, p. 3; Morse 1904, Proc. Ohio Acad. Sci. 4, p. 112; Ditmars 1905, Amer. Mus. Journ. 5, 4, p. 172, f. 8; Browne 1905, Roger Williams Park Mus. Mon.

15, p. 18; Clark 1905, Rept. Michigan Acad. Sci. 7, p. 109; Stone 1906, Amer. Nat. 40, p. 161; Fowler 1906, Amer. Nat. 40, p. 743; Ruthven 1906, Rep. Geol. Michigan 1905, p. 107; Brimley 1907, Proc. Elisha Mitchell Sci. Soc. 23, p. 155; Fowler 1907, Rep. New Jersey Mus. 1906, p. 59. pl. 10; McAtee 1907, Proc. Biol. Soc. Washington 20, p. 14; Banta 1907, Carnegie Inst. Pub. 67, p. 22; Hahn 1908, Proc. U. S. Nat. Mus. 35, p. 553; Fowler 1908, Rep. New Jersey Mus. 1908, p. 393; Strecker 1908, Proc. Biol. Soc. Washington 21, p. 55; 1908, l. c., p. 80; 1908, l. c., p. 88; Reed and Wright 1909, Proc. Amer. Phil. Soc. 48, p. 403; Hurter and Strecker 1909, Trans. Acad. Sci. St. Louis 18, 2, p. 17; Brimley 1909, Proc. Biol. Soc. Washington 22, p. 131; 1910, same, 23, p. 10; Hurter 1911, Trans. Acad. Sci. St. Louis 20, p. 83; Brimley 1912, Proc. Biol. Soc. Washington 25, p. 137; Surface 1913, Zoöl. Bull. Pennsylvania Dept. Agric. 3, 3-4, p. 96, f. 8, pl. 6, f. 1; Keim 1914, Copeia 2; Deckert 1914, Copeia 13; Strecker 1915, Baylor Bull. 18, 4, p. 55; Keim 1915, Copeia 24, p. 51; Dunn 1915, Copeia 25, p. 63; Brimley 1915, Journ. Elisha Mitchell Sci. Soc. 30, p. 5; Okey 1916, Ohio Journ. Sci. 17, p. 25 (cranial nerves, eggs); Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 25; Mattern and Mattern 1917, Copeia 46, p. 64; Dunn 1917, Bull. Amer. Mus. Nat. Hist. 37, p. 603, f. 2, pl. 57, f. 5; Shufeldt 1917, Aquatic Life, p. 25; Stejneger and Barbour 1917, Check List, p. 16; Dunn 1918, Copeia 53, p. 19; 1918, Bull. Mus. Comp. Zoöl. 62, p. 459; Uhlenhuth 1919, Copeia 69, p. 27; Wright and Moesel 1919, Copeia 72, p. 64; Potter 1920, Copeia 86, p. 82; Ortenburger 1921, Copeia 99, p. 73; Noble 1921, Bull. Amer. Mus. Nat. Hist. 44, p. 5 (septomaxilla); Löding 1922, Alabama Mus. Pap. 5, p. 13; Blanchard 1922, Occ. Pap. Mus. Zoöl. U. Michigan 117, p. 3; Breder and Breder 1923; Zoölogica 4. 1, p. 14; Bishop 1923, Copeia 118, p. 66; Stejneger and Barbour 1923, Check List (2), p. 10; Wilder 1924, Amer. Nat. 58, p. 538, f. 2a; Brady 1924, Copeia 130, p. 55; Myers 1924, Copeia 131, p. 59; Schmidt 1924, Copeia 132, p. 68; Bishop 1924, New York Mus. Bull. 253, p. 89; Crozier 1924, Amer. Nat. 58, p. 480, f. 1 (rigor mortis); Pope 1924, Amer. Mus. Nov. 153, p. 2; Bishop 1925, Copeia 139, p. 10; Brimley 1925, Copeia 139, p. 14; Fowler 1925, Copeia 145, p. 62; Noble 1925, Journ. Morph. 40, p. 400 f. 39 (heart).

1850 *Plethodon glutinosum* Gray, Cat. Batr. Grad. Brit. Mus., p. 39.

1920 *Plethodon glutinosus glutinosus* Dunn, Proc. Biol. Soc. Washington 33, p. 131.

1818 *Salamandra variolata* Gilliams, Journ. Acad. Nat. Sci. Philadelphia 1, p. 460 (Southern States); Harlan 1826, same, 5, p. 334.

1825 *Salamandra cylindracea* Harlan, Journ. Acad. Nat. Sci. Philadelphia 5, p. 156 (South Carolina); 1856, same, p. 328.

1842 *Triton porphyriticus* DeKay, Zoöl. New York 3, p. 86, pl. 16, f. 37 (New York City).

1854 *Plethodon variolosum* Duméril and Bibron, Erp. Gén. 9, p. 83, pl. 94, f. 4.

1854 *Salamandra albopunctata* Valenciennes in Duméril and Bibron, Erp. Gén. 9, p. 81 (Savannah, Ga.).

1854 *Salamandra elongata* Valenciennes in Duméril and Bibron, Erp. Gén. 9, p. 84.

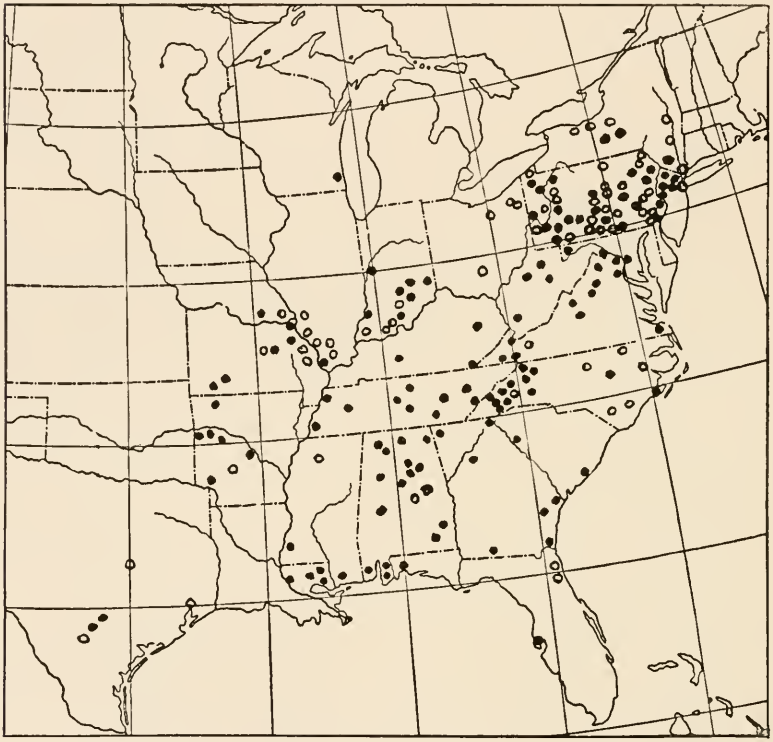
1865 *Salamandra melanoleuca* Wied, Nov. Act. Leopold-Carol. 32, p. 130 (Nazareth, Pa.).

Type: Not known to exist.

Type locality: Not mentioned but obviously Princeton, N. J.

Range: Southern New York to Northern Florida, Wisconsin and Texas.

Diagnosis: A large *Plethodon;* black with white pigment spots usually all over dorsal surface; long vomerine series; 14-5 costal grooves.



12. Eastern United States, showing localities for Plethodon glutinosus.

Description: Adult female, my own collection; Nashville, Tenn.; 14-15 costal grooves; 4 costal folds between appressed toes; head width 7 in length from snout to vent; head length about 4 in length of body; eye shorter than its distance from tip of snout; outline of upper

jaw straight; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind gular fold; limbs well developed; fingers 3, 2, 4, 1 in order of length, webbed at base; toes 3, 4, 2, 5, 1 in order of length, webbed at base; vent without papillae; tail terete, longer than head and body; vomerine teeth 13 in series, beginning beyond outer edge of nares, separated from fellow by width of nares, and from parasphenoids by twice width of nares; latter in a single patch, beginning at middle of eyesocket; black, palms and soles white; white pigment spots scattered over sides and over tail; total length 182, head 17, body 66, tail 99.

Variation: A male, same data; differs in having three costal folds between appressed toes; papillae in vent; no other variations or perceptible sexual dimorphism.

Another female with same data has the parasphenoids in two patches.

I have seen specimens from near Charleston, S. C., with no white pigment spots (Field No. 5794-5), and Schmidt (1924) says of the series from which these two examples were taken that 12 out of 77 were not spotted. Hallowell (1858), and Cope (1889) also mention this local variety. The approach to *metcalfi* is solely in the absence of the white pigment spots and these specimens do not share in the general weakening of black pigment so characteristic of *metcalfi*, nor do they have the shorter vomerines of that form.

Cope (1889) records young from Montgomery Co., Va., as having "small bright red spots on each side." I have seen one young specimen from Clayton, Ga., which had tiny paired dorsal red spots as do many young *wehrlei*.

Measurements of a series from Brevard and Linville, N. C., in the Amer. Mus. Nat. Hist. follows:

Length	*Head*	*Body*	*Tail*	*Length*	*Head*	*Body*	*Tail*
129	14	60	55	142	16	53	73
128	16	60	52	135	14	51	70
155	15	59	81	108	12	43	53
148	15	58	75	49	7	21	21
159	16.5	57.5	85	41	6	19	15
142	15	57	70	45	6.5	18.5	20
146	16	53	77	42.5	6	16.5	20

Habits: Very little has been published or observed on the habits of

this common form. It has the general terrestrial forest habitat of the rest of the genus, and is found generally in and under dead logs and other debris on the forest floor. They make quite extensive burrows, sometimes opening onto the side of a road cutting, and I have seen it in such a situation lying in the mouth of its burrow as a toad does. It is much the most slimy of the genus.

The eggs have apparently been observed by Okey (1916) who speaks of "embryoes . . . taken from four lots of eggs collected at the same time," these were 6-11.5 mm. long, but the eggs are not described anywhere.

Remarks: Close to *yonahlossee* and to *wehrlei*, this species is sufficiently distinct from either. Aside from any other character, the throat of *glutinosus* is much darker than in any of the other large *Plethodons*. The vomerines are intermediate in length between those of *yonahlossee* and those of *wehrlei*. The arrangement of the white pigment spots as a lateral band, the usual presence of dorsal red pigment in the young, the lightness of the under surface, and the mutual exclusiveness of their ranges, tend to make the alliance of *yonahlossee* and *wehrlei* probable, although *yonahlossee* and *glutinosus* agree in a more primitive body form and *wehrlei* is more elongate.

Its striking external similarity to *Ambystoma jeffersonianum* has given rise to many erroneous records for *glutinosus* in New England and in Michigan. There is no real evidence for its occurrence in either of these regions.

Specimens seen 774, as follows:

Vermont: Caledonia Co. 3 (Carnegie No. 171-3). Locality erroneous?

Massachusetts: no locality 1 (M. C. Z. No. 1200).

New York: Mountainville 1 (A. M. N. H. No. 12864); Cazenovia 1 (A. N. S.); Ithaca 2 (M. C. Z. No. 4412, U. S. N. M. No. 39406).

New Jersey: Orange 12 (U. S. N. M. No. 3767); Kingwood 1 (A. N. S.); Plainfield 3 (M. C. Z. No. 2288); Swartswood Lake 1 (A. N. S.); Schooley's Mt. 3 (M. C. Z. No. 158).

Pennsylvania: Delaware Co. 2 (U. S. N. M. No. 3762); Pike Co. 1 (A. N. S.); Bartonville 1 (A. N. S.); Newhope 1 (A. N. S.); York Furnace 1 (A. N. S.); Northhumberland Co. 5 (Carnegie No. 223-7); Pine Grove 1 (Carnegie No. 276); Tuscarora 1 (A. N. S. No. 4799); Eaglesmere 1 (A. N. S.); Lockhaven 1 (Carnegie No. 1691); Carlisle 55 (U. S. N. M. No. 3754, 7905); Warren 1 (A. N. S.); Meadville 12 (U. S. N. M. No. 3759); Westmoreland Co. 1 (Carnegie No. 188); Laughlintown 22 (Carnegie No. 249-62, 272-5, 277-80); New Florence 1 (Carnegie No. 219); Beaver 5 (Carnegie No.

246-7, 270-1, 282); Roscoe 1 (Carnegie No. 221); Cambria Co. 3 (Carnegie No. 185-7); Cresson 4 (Carnegie No. 248, 263, 269, 281); Altoona 1 (A. N. S.); Ohiopyle 11 (A. N. S., Carnegie No. 236-45); Diamond Valley 1 (A. N. S.); Franklin 1 (A. N. S.); Indiana Co.: Two Lick Hills 1 (A. N. S.); Two Lick Cr. 1 (A. N. S.); Burnhamer Run 1 (A. N. S.); Indiana 1 (A. N. S.); Allegheny Co.: Moon 2 (Carnegie No. 169-70); McKees Rocks 11 (Carnegie No. 174-81, 2805-7); Boston 11 (Carnegie No. 147-57); Fern Hollow 4 (Carnegie No. 163-6); Montour Run 7 (Carnegie No. 189-200, 2796-800); Thornburg 2 (Carnegie No. 2886-7); West View 2 (Carnegie No. 201-2); McKeesport 7 (Carnegie No. 203-9); Sewickley 2 (Carnegie No. 211-2); Pittsburgh 1 (Carnegie No. 220); Edgeworth 1 (Carnegie No. 222); Carnegie 2 (Carnegie No. 1508-9); Squaw Run 1 (Carnegie No. 1690); Pine Cr. 5 (Carnegie No. 2801-4, 1151); Perrysville 1 (Carnegie No. 210); Coraopolis 8 (Carnegie No. 228-35); Pitcairn 2 (Carnegie No. 1503-4).

Maryland: Jennings 1 (A. N. S.).

District of Columbia: Washington 1 (U. S. N. M. No. 13315).

Virginia: Arlington Co.: Spout Run 1 (U. S. N. M. No. 55469); Fairfax Co. 1 (U. S. N. M. No. 13316); Plummer's I. 1 (U. S. N. M. No. 30697); Potomac Bluffs 1 (U. S. N. M. No. 66143); Great Falls 1 (Blanchard); Langley 1 (U. S. N. M. No. 30703); Dunn Loring 1 (U. S. N. M. No. 17462); Franconia 1 (E. R. D.); Dyke 2 (U. S. N. M. No. 55468, 62058); Mt. Vernon 15 (M. C. Z. No. 5151-4, U. S. N. M. No. 55097, 61938-40, E. R. D.); Clarke Co. 1 (U. S. N. M. No. 3779); Berry's Ferry 1 (E. R. D.); Delaplane 2 (U. S. N. M. No. 39031-2); Nelson Co., Midway 1 (M. C. Z. No. 6502); Norfolk 1 (U. S. N. M. No. 4889); Thornton Gap, Page Co. 10 (U. S. N. M. No. 59882-91); Stony Man Mt. 1 (U. S. N. M. No. 31630); Bedford Co. 2 (U. S. N. M. No. 36710-1); O'Connell's, Augusta Co. 11 (U. S. N. M. No. 36719-20, 36730-1, 36733, 36742-4, 36750, 36753, 36755); Horsepen Cr., Tazewell Co. 2 (U. S. N. M. No. 33634-5); Abingdon 1 (E. R. D.); White Top Mt. 12 (M. C. Z. No. 6506-17).

North Carolina: Beaver Cr., Ashe Co. 16 (Breder); Blowing Rock 2 (U. Pa.); Linville 52 (M. C. Z. No. 6576-90, A. M. N. H. No. 4645-63, 4668-9, 4789-98, 4864-9); Cane R. 1 (U. S. N. M. No. 31155); Asheville 1 (E. R. D.); Blantyre 2 (U. S. N. M. No. 38244-5); Brevard 39 (A. M. N. H. No. 4097, 4114-25, 4127-9, 4341, 4471-5, 4452); Pisgah Forest Reserve 4 (A. M. N. H. No. 4434-6, 4453); Waynesville 16 (Chapin); Mt. Sterling 2 (M. C. Z. No. 6492-3); Catawba Co. 1 (M. C. Z. No. 1382); Apex 2 (Field No. 813-4); Lake Ellis 2 (Field No. 1981); Raleigh 6 (Field No. 1982, U. S. N. M. No. 16636, 49684, 22176).

South Carolina: Abbeville 5 (U. S. N. M. No. 3782); Calhoun Falls 1 (Field No. 815); Goose Cr. 2 (U. S. N. M. No. 14453); Seabrook 1 (M. C. Z. No. 993); Mt. Pleasant 2 (M. C. Z. No. 9354-5); Charleston 9 (Field No. 5794-5, U. S. N. M. No. 3784, M. C. Z. No. 205, 209, 1743); no locality 2 (A. N. S., U. S. N. M. No. 5018).

Georgia: Clayton 6 (Davis); Tallulah Falls 1 (M. C. Z. No. 4413); Chickamauga 1 (A. N. S.); Gwinnett Co. 1 (U. S. N. M. No. 38546); Nashville 1 (U. S. N.

M. No. 11899); Savannah 1 (U. S. N. M. No. 21378); Riceboro 10 (U. S. N. M. No. 3781, 45830); St. Mary's 2 (M. C. Z. No. 2335); no locality 11 (M. C. Z. No. 221, 242, 4600-2, U. S. N. M. No. 3756, 5267).

Florida: Milton 1 (U. S. N. M. No. 11960); Gulfport 1 (M. C. Z. No. 7084).

Alabama: Leighton 1 (U. S. N. M. No. 51457); Anniston 3 (M. C. Z. No. 6503-5); Tuscaloosa Co. 1 (U. S. N. M. No. 57083); University 1 (U. Ala.); Fort William Shoals, Talladega Co. 1 (U. Ala.); Shoal Cr., St. Clair Co. 1 (U. Ala.); Maplesville 3 (M. C. Z. No. 4414-6); Uniontown 1 (A. N. S.); Dayton 1 (U. S. N. M. No. 3757); Moulton 1 (U. S. N. M. No. 9288); Madison Co. 1 (U. S. N. M. No. 57084); Pinckard 1 (U. Ala.); Ft. Payne 1 (U. Ala.); Barbour Co. 1 (U. Ala.); Mobile 1 (M. C. Z. No. 4745); Baldwin Co. 2 (U. S. N. M. No. 57085-6); Magnolia Springs 1 (U. Ala.).

Mississippi: Natchez 7 (U. S. N. M. No. 3773); Washington 1 (U. S. N. M. No. 45919); Bay St. Louis 1 (U. S. N. M. No. 45918).

West Virginia: Bristol 1 (M. C. Z. No. 7363); Petroleum 1 (M. C. Z. No. 991); Jefferson Co. 2 (U. S. N. M. No. 60073-4); South Fork Files Cr., Cheat Mt. Cove 1 (U. S. N. M. No. 33651); Baileysville 3 (U. S. N. M. No. 33586-7, 33633); no locality 1 (M. C. Z. No. 990).

Ohio: no locality 1 (A. N. S.).

Indiana: Brookville 1 (U. S. N. M. No. 4844); Wyandotte 1 (M. C. Z. No. 7032); Crawford Co. 1 (M. C. Z. No. 7026); Medora 1 (M. C. Z. No. 7037); Brown Co. 1 (M. C. Z. No. 7036); Monroe and Vigo Co.'s 4 (M. C. Z. No. 7027-30); Vincennes 2 (M. C. Z. No. 7031, 7035).

Illinois: Olive Branch 38 (Field No. 2185-9, 2209); Aux Plaines R., West Northfield 1 (U. S. N. M. No. 3775); Northfield 1 (U. S. N. M. No. 9481); "southern" 30 (U. S. N. M. No. 8024).

Wisconsin: Racine 5 (U. S. N. M. No. 3789).

Kentucky: Cumberland Gap 6 (M. C. Z. No. 1397); Morgan Co. 2 (U. S. N. M. No. 57078-9); Edmonson Co. 1 (M. C. Z. No. 2228); Mammoth Cave 2 (U. S. N. M. No. 24494-5).

Tennessee: Spring City 10 (M. C. Z. No. 6566-75); Sevier Co. 1 (M. C. Z. No. 7049); Knoxville 1 (A. N. S.); Sawyer's Springs 1 (A. N. S.); Chattanooga 1 (A. N. S.); Samburg 1 (A. N. S.); Murfreesboro 1 (A. N. S.); Raleigh 1 (A. N. S.); Maxey 7 (U. S. N. M. No. 28401-7); Tyree Springs 6 (U. S. N. M. No. 3760); Nashville 6 (E. R. D.); Big Sandy 1 (U. S. N. M. No. 45957).

Missouri: Jefferson Co. 7 (M. C. Z. No. 3155, Field No. 2657, U. S. N. M. No. 57072-6); St. Louis Co. 5 (U. S. N. M. No. 18015-7, 57067-8); Crawford Co. 1 (U. S. N. M. No. 57071); Osage R. 5 (M. C. Z. No. 195); Chadwick 1 (A. N. S.); Stone Co. 2 (U. S. N. M. No. 57069-70); Marble Cave 5 (Field No. 2656, U. S. N. M. No. 45792-4, 57992); Montgomery Co. 1 (U. S. N. M. No. 57077); Union Co. 13 (U. S. N. M. No. 3761):

Arkansas: Carroll Co. 1 (U. S. N. M. No. 57082); Pulaski Co. 2 (Field, U. S. N. M. No. 57080); Petit Jean 1 (A. N. S.); Magazine 1 (A. N. S.); Blue Mountain 1 (A. N. S.); Delight 1 (U. S. N. M. No. 57081); no locality 2 (M. C. Z. No. 178).

Louisiana: Mandeville 4 (Viosca, U. S. N. M. No. 8876); Covington 1 (U. S. N. M. No. 53178); Bogalusa 2 (Viosca); Indian Mound 10 (Viosca).

Texas: San Marcos 2 (M. C. Z. No. 4541-2); New Braunfels 3 (U. S. N. M. No. 4725); no locality 1 (U. S. N. M. No. 55342).

It has also been recorded from the following additional localities:

Canada: Strait of Belle Isle (Putnam 1866, error for *Ambystoma jeffersonianum*); Quebec (Provancher 1874-5, error); southern New Brunswick (Cox 1898, error).

Maine: no locality (Fogg 1862, error).

New Hampshire: Hanover (Worthen 1891, error).

Vermont: no locality (Thompson 1842, error).

Massachusetts: Andover (Storer 1839, error for *A. jeffersonianum*); Springfield (Allen 1868, error); Worcester (Horr in litt., error); Ipswich (Henshaw 1904, error); Essex and Hamilton (Dunn 1918, error for *A. jeffersonianum*).

Rhode Island: Scituate, Cumberland and Providence (Drowne 1905, error).

Connecticut: Northford (Linsley 1844, error).

New York: Coxsackie (Baird 1852); Staten I. (Davis 1884); New York City (DeKay 1842); Hudson Highlands (Mearns 1898); White Plains (Deckert 1914); Palisades (Ditmars 1905); Albany Co. (Bishop 1923); Onondaga Co. (Britcher 1903); Wayne Co., Monroe Co. (Wright and Moesel 1919).

New Jersey: High Bridge, Hunterdon Co. (Fowler 1908); New Brunswick (Crozier 1924).

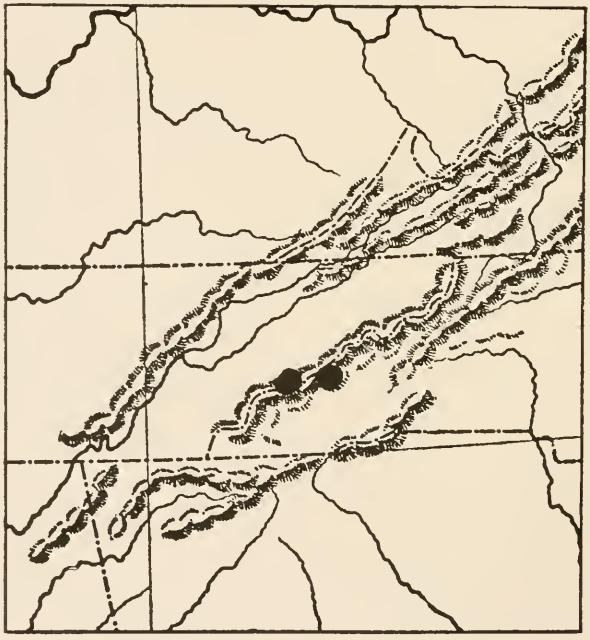
Pennsylvania: Susquehanna Co., Kingsley; Wyoming Co., Falls, Meshoppen; Monroe Co., Shawnee; Northampton Co., Easton, Bethlehem (Surface 1913); Nazareth (Wied 1865); Lehigh Co., Summit Lawn (Mattern and Mattern 1917); Montour Co., Danville; Berks Co., Kutztown, Wernersville, Robesonia; Dauphin Co., Lykens, Williamstown, Harrisburg, Penbrook, Dauphin, Rockville (Surface 1913); Chester Co. (Cope 1862); Montgomery Co., Rahns; Lycoming Co., Williamsport (Surface 1913); Loyalsock; Tioga Co., Blossburg (Bishop 1925); Union Co., Millmont; Center Co., Port Matilda (Surface 1913); State College (Bishop 1925); Cumberland Co., Enola; Huntington Co., Huntington; Perry Co., Marshrun, Landisburg, Blain; York Co., York, Peachbottom; Franklin Co., Mont Alto, Mercersburg; Fulton Co., McConnellsburg, Warfordsburg; Adams Co., Zora (Surface 1913); Arendtsville, Aspers (Bishop 1925); Erie Co., Union City; Venango Co., Cherrytree; Jefferson Co., Port Matilda; Forest Co., Starr; Indiana Co., Shelocta; Cambria Co., Johnstown, Wilmore; Armstrong Co., Parkers Landing; Beaver Co., New Brighton; Allegheny Co., Westville, Wilkinsburg, Swissvale, Crafton; Washington Co., Canonsburg; Westmoreland Co., Vandergrift; Somerset Co., Myersdale; Fayette Co., Belle Vernon (Surface 1913).

Virginia: Montgomery Co. (Cope 1889).

North Carolina: Chapel Hill, Littleton, Lumberton, Greenville (Brimley 1915); Wilmington (Myers 1924); Flat Rock (Pope 1924); Mt. Pisgah, Oteen, Minehole Gap, Stoney Mt. (Bishop 1924); Willard, Pender Co. (Brimley 1925).

South Carolina: Otranto, Summerville (Schmidt 1924).

Georgia: Akron (Burnett 1852); Mimsville (Brimley 1910).
Florida: Green Cove Springs (Brimley 1910); Jacksonville (Cope 1871).
Alabama: Macon Co., Montgomery Co. (Löding 1922).
Mississippi: La Fayette Co. (Potter 1920).
West Virginia: Harper's Ferry (Schufeldt 1917).
Ohio: Sugar Grove (Morse 1901); Lorain Co., Youngstown, Newton Falls (Morse 1904).
Indiana: Mitchell (Hahn 1908); Mayfield's Cave (Banta 1907); Terre Haute, Crawfordsville (Hay 1903); Vanderburg Co., Perry Co., Spencer Co. (Ortenburger 1921).
Illinois: Makanda, Cobden, Saratoga (Garman 1892); St. Clair Co., Madison Co., Randolph Co. (Hurter 1911).
Michigan: Kent Co. (Clarke 1907, error); Marquette Co. (Ruthven 1906, error for *A. jeffersonianum*).
Missouri: St. Charles Co., St. Francois Co., Phelps Co., Madison Co. (Hurter 1911).
Arkansas: Hot Springs (Strecker 1908).
Texas: Helotes (Cope 1880); McLennan Co. (Strecker 1908); Cleveland, Liberty Co. (Strecker 1915).



13. Southern Appalachians, showing localities for Plethodon jordani.

PLETHODON JORDANI BLATCHLEY

1901 *Plethodon jordani* Blatchley, Ann. Rept. Dept. Geol. Indiana (1900), p. 762; Stejneger 1906, Proc. U. S. Nat. Mus. 30, p. 560, f. 3; Stejneger and Barbour 1917, Check List, p. 16; Dunn 1920, Proc. Biol. Soc. Washington 33, p. 131; Stejneger and Barbour 1923, Check List (2), p. 11.

Type: Originally in collection of W. S. Blatchley; now destroyed.

Type locality: Mt. Collins and Indian Pass, Sevier Co., Tenn.

Range: Great Smoky Mts.

Diagnosis: A *Plethodon* with 14 costal grooves, no white pigment spots, cheeks red.

Description: M. C. Z. No. 8712, adult male, Mt. Sterling, N. C., 4,000-4,500 feet; 14 costal grooves; appressed toes meeting; head width 6 in length from snout to vent; head length 3⅓ in length of body; head a blunt oval; snout swollen; eye shorter than its distance from tip of snout; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 2, 5, 1 in order of length; tail terete, longer than head and body; vent lined with papillae; black, lighter below, especially on throat; sides of head from eye to gular fold red; total length 129, head 15, body 49, tail 65. Variation: a female, M. C. Z. No. 8709, same data, differs in having appressed toes separated by 1 costal fold; head width 5 in length of body; snout not swollen; no papillae in vent; vomerine teeth 14 in series, beginning beyond outer edge of nares, separated by width of nares and from the parasphenoids by the same distance; latter in a single patch; no red on sides of head; total length 95, head 17, body 59, tail 19; vomerine teeth 9 in series, beginning behind outer edge of nares, separated by 3 times width of nares, and from parasphenoids by same distance; latter in two patches, beginning opposite anterior quarter of eyesocket.

A young specimen, M. C. Z. No. 8694, same data, has a white belly; total length 28, head 5, body 13, tail 10.

Three in the series of 37 which I collected at Mt. Sterling lacked the red stripe on the side of the head. One of these had red dots on the legs. The specimens vary in the size of the stripe and in the amount of pigment present.

Habits: In general this form appears similar in its habits to the

rest of the *glutinosus* group. From what I was able to observe on White Rock it is not so agile as *metcalfi*, but like it, is nothing like so slimy as *glutinosus* or *yonahlossee*. Furthermore it seemed much more partial to rotten logs than any other *Plethodon* I have come across.

Remarks: Closely related to *P. shermani* of the Nantahalas, and to *P. metcalfi* of most of the other ranges of the Southern Blue Ridge. The vomerine tooth series is longest in *jordani* and shortest in *shermani*. The black color is deepest in *jordani* and lightest in *metcalfi*. All known *shermani* have red legs, and most of the known *jordani* have a red stripe on the sides of the head. The legs of *jordani* seem longer than those of the other two. But the three are very close, do not occur together, and it is by no means impossible that they intergrade. The most primitive is probably *jordani*.

Specimens seen 38, as follows:

Tennessee: No locality (probably from the Smokies) 1 (U. S. N. M. No. 35597).
North Carolina: White Rock Mt., near Mt. Sterling, 4,000-4,500 feet 37 (M. C. Z. No. 8686-8717).

It has also been recorded from Mt. Collins and Indian Pass, Sevier Co., Tennessee (Blatchley 1901).

PLETHODON SHERMANI STEJNEGER

1906 *Plethodon shermani* Stejneger, Proc. U. S. Nat. Mus. 30, p. 559, ff. 1, 4. 5: Brimley 1912, Proc. Biol. Soc. Washington 25, p. 138; Stejneger and Barbour 1917, Check List, p. 16; 1923, Check List (2), p. 11.

Type: U. S. Nat. Mus. No. 36214, collected by F. Sherman, Aug. 24, 1904.

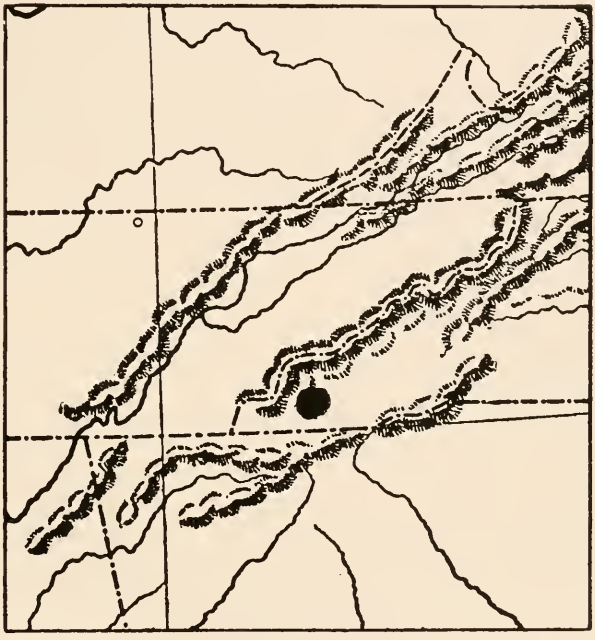
Type locality: Wayah Bald Mt., in Nantahala Range between Franklin and Aquone, N. C. (Originally and erroneously given as between Aquone and Andrews).

Range: Nantahala Mts.

Diagnosis: A *Plethodon* with 14 costal grooves, no dorsal light marking, no white pigment spots, legs red.

Description: U. S. Nat. Mus. No. 38240, adult male, Wayah Bald Mt., N. C.; 14 costal grooves; 3 costal folds between appressed toes; head width 5⅔ in length from snout to vent; head length 3½ in length of body; head a blunt oval; eye shorter than its distance from

tip of snout; snout slightly swollen; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length, free; toes free 4, 3, 2, 5, 1 in order of length; tail longer than body, terete; vent lined with papillae; vomerine teeth 9 in series, beginning behind outer edge of nares, run-



14. Southern mountains, showing locality for Plethodon shermani.

ning in and back, separated from fellow by ¾ its length, and from parasphenoids by same distance; latter in one patch, divided anteriorly, beginning opposite first fourth of eyesocket; black above, lighter below, especially light on throat; upper lip light; upper arm, a spot on fore arm, knee, and spot on lower leg light (red in life); total length 124, head 15, body 52, tail 57.

Variation: U. S. N. M. No. 36214, Type, same locality, adult male, differs in having head width 6⅔ in length from snout to vent; head length 3¾ in length of body; one costal fold between appressed toes; tail longer than head and body; 7 teeth in vomerine series; parasphenoid patches completely divided; total length 112, head 11, body 41, tail 60.

A young specimen, U. S. N. M. No. 38241, same locality, has appressed toes meeting; head width 5½ in length from snout to vent; head length 3¼ in length of body; much lighter below and on sides than two adults; tail distinctly bicolor; sides light as far up as a line above insertions of legs; total length 64, head 8, body 26, tail 30.

Habits: Brimley (1912) says: "Under logs near a little stream."

Remarks: Closely allied to *jordani* of the Smokies, and like it apparently a form of *metcalfi* which occurs on most of the other ranges above 3,000 feet.

Specimens seen 3, as follows:

North Carolina: Wayah Bald Mt. 3 (U. S. N. M. No. 36214 TYPE, 38240-1).

PLETHODON METCALFI BRIMLEY

1895 *Ambystoma jeffersonianum* Rhoads, Proc. Acad. Nat. Sci. Philadelphia, p. 402.

1909 *Plethodon shermani* Howell, Auk 26, p. 131.

1912 *Plethodon metcalfi* Brimley, Proc. Biol. Soc. Washington 25, p. 138, pl. 6, ff. 1, 2, 4, 7-11; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 23; Dunn 1917, Bull. Amer. Mus. Nat. Hist. 37, p. 604, f. 3, pl. 57, f. 4; Stejneger and Barbour 1917, Check List, p. 16; Dunn 1920, Proc. Biol. Soc. Washington 33, p. 132; Noble 1921, Bull. Amer. Mus. Nat. Hist. 44, p. 5 (skull); Stejneger and Barbour 1923, Check List (2), p. 11; Breder and Breder 1923, Zoologica 4, 1, p. 14; Holt 1924, Copeia 135, p. 94; Bishop 1924, New York St. Mus. Bull. 253, p. 96; Pope 1924, Amer. Mus. Nov. 153, p. 2.

Type: U. S. N. M. No. 49682, collected by Brimley and Sherman, May, 1912.

Type locality: Sunburst, Haywood Co., N. C., altitude 3,500-4,000 feet.

Range: From White Top Mt., Va., to Brasstown, Bald Mt., Ga., and Long Island, Jackson Co., Ala. It apparently occupies all the ranges of the Southern Blue Ridge except the Great Smokies and the Nantahalas. The Alabama record is on the Cumberland Plateau.

Diagnosis: A *Plethodon* with 14-15 costal grooves; no white pigment spots; no red or yellow markings; throat whitish.

Description: M. C. Z. No. 6313, adult male, White Top Mt., Va., 15 costal grooves; appressed toes meeting; head with 6 in length from snout to vent; head length 3½ in length of body; head oval; eye as long as its distance from tip of snout; snout swollen, a tubercle below nostril; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 4, 2, 1 in order of length, slightly webbed; toes 4, 3, 2, 5, 1 in order of length, slightly webbed; vent lined with papillae; tail terete, longer than head and body; vomerine teeth 7-9 in series, beginning behind middle of choanae, running in and back, separated from its fellow by twice width of nares and from parasphenoids by three times width of nares or by length of vomerine series; latter in a single patch beginning opposite last third of eyesocket; black above, light below a line joining insertions of legs; lower half of tail light; total length 117, head 13, body 45, tail 59.

Variation: A female, M. C. Z. No. 6298, same data, has two costal folds between appressed toes; no papillae in vent; snout not swollen; vomerine teeth 12, beginning beyond nares, separated from fellow by width of nares and from parasphenoids by twice that distance; total length 111, head 13, body 47, tail 51.

A young specimen, M. C. Z. No. 6332, same data, is not pigmented below, purplish gray above; total length 35, head 5, body 16, tail 14.

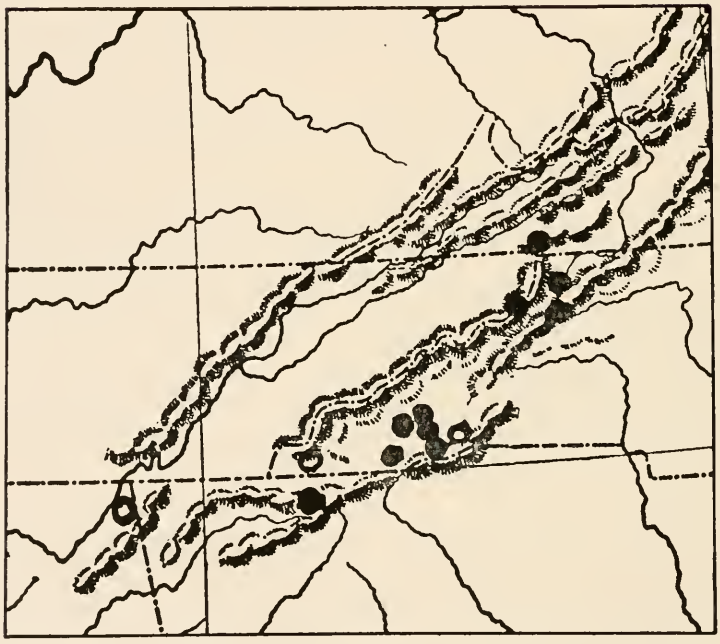
According to Brimley it may reach 140 mm., but of over 200 specimens collected by myself the largest was 119 mm.

Breder and Breder (1923) mention one which had a few white areas on the sides. Ordinarily the white pigment spots, so common in *glutinosus*, are totally lacking in this species. The belly lacks the larger unpigmented dots of *glutinosus*. The general paleness of the coloration both dorsal and, more markedly, ventral is caused by the weakening of the dark borders of the tiny unpigmented dots which cover the whole surface of this and the related forms. The vomerine series are ordinarily short, oblique and curved, extending a little farther than the outer border of the nares, containing 6-7 teeth, separated from its fellow by ⅓ the length of the series and from the

parasphenoids by more than the length of the series. The latter are confluent or divided by a narrow groove.

Measurements of a series from Linville in the American Museum follow:

Length	*Head*	*Body*	*Tail*	*Length*	*Head*	*Body*	*Tail*
98	13	48	37	80	11	35	34
119	13	47	59	47	6	20	21
116	13	46	57	48	6	18.5	23
115	12	43	60	42	6	16	20
108	12	42	53	40	6	16	18
97	11	36	50	35	5.5	14.5	15
96	10	36	50				



15. Southern mountains, showing localities for Plethodon metcalfi.

Habits: Extremely common in the oak-chestnut forests on the mountains from 3,000 feet up. Its habits resemble those of *glutinosus*, but it is less slimy and more agile than that species.

Remarks: This species is related to *jordani* of the Smokies and to *shermani* of the Nantahalas. It has no red pigment on sides of head or on legs and less black pigment all over. It seems a somewhat more specialized form than either *jordani* or *shermani,* but it has much the widest range, and apparently the three occupy distinct areas. *Metcalfi* is known from Roan and White Top in the Iron Mts.; Grandfather Mt., Beaver Creek, and See-Off in the Blue Ridge; Pisgah Forest Reserve in the Pisgah Ridge; Sunburst in the Balsams; Highlands in the Cowee Mts.; between Andrews and Aquone in the Tuskwitty Range; thus few ranges are left from which a member of this group remains unknown. The most remarkable exception to this statement is the Black Mts., in which so much collecting has been done. *Metcalfi* should certainly occur on Mt. Mitchell. Intergrades between these three might be expected to occur on some of the ranges joining the Balsams, Nantahalas, and Great Smokies.

Specimens seen 331, as follows:

Virginia: White Top Mt. 60 (M. C. Z. No. 6291-6360).
Tennessee: Roan Mt. 13 (A. N. S.).
North Carolina: Beaver Creek, Ashe Co. 4 (Breder); Linville 203 (A. M. N. H. No. 4601-32, 4670-1, 4799-850, 4880-942, 5001-2, M. C. Z. No. 6361-399); Sunburst, Haywood Co. 3 (U. S. N. M. No. 49682 TYPE, 49683, M. C. Z. No. 2888); Haywood Co. and Watauga Co. 3 (U. S. N. M. No. 57020-2); Waynesville 33 (Chapin); Pisgah Forest Reserve 6 (A. M. N. H. No. 4428-33); See-off, Transylvania Co. 3 (A. M. N. H. No. 4163-4, 4166); Highlands 1 (U. S. N. M. No. 38243); no locality 1 (U. S. N. M. No. 38242).
Georgia: Brasstown Bald Mt. 1 (U. S. N. M. No. 45358).

It has also been recorded from the Tuskwitty range between Andrews and Aquone, N. C. (Brimley 1912); Flat Rock, N. C. (Pope 1924); and Long Island, Jackson Co., Ala. (Holt 1924).

PLETHODON VANDYKEI VAN DENBURGH

1906 *Plethodon vandykei* Van Denburgh, Proc. California Acad. Sci. (3), Zoöl., 4, 4, p. 61; Stejneger and Barbour 1917, Check List, p. 17; 1923, Check List (2), p. 11; Noble 1925, Amer. Mus. Nov. 166, p. 5 (eggs); Noble 1925, Journ. Morph. 40, p. 375, f. 21 (skin).

Type: California Acad. Sci. No. 6910 (now destroyed), collected by Dr. E. C. Van Dyke, July, 1905.

Type locality: Paradise Valley, Mt. Rainier Park, Washington.

Range: Mountains of western Washington; Cascades and Olympics.

Diagnosis: A *Plethodon* with 12-13 costal grooves, toes webbed at base, a parotoid gland, and a light dorsal stripe.

Description: U. Mich. No. 54219, adult male, edge of Skokomish river at Devil's Staircase, Mason Co., Washington; 12 costal grooves, 1 costal fold between appressed toes; head width 5⅔ in length from snout to vent; head length 3⅘ in length of body; head a blunt oval; eye as long as its distance from tip of snout; snout somewhat swollen, a tubercle below nostril; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; a groove from former which curves dorsally and back to meet an upward extension of gular fold, thus delimiting parotoid gland; limbs well developed; fingers 3, 2, 4, 1 in order of length, webbed at base and to tip of 1; toes 3, 4, 2, 5, 1 in order of length, webbed at base and to tip of 1; tail shorter than body, rather trigonal in cross section; anal lips lined with papillae; vomerine teeth 10 in series, beginning behind inner border of nares, running in and back, separated from its fellow by ⅓ length of series and from parasphenoids by the same distance; latter in a single patch, beginning opposite middle of eyesocket; 4 enlarged teeth on premaxilla; reddish brown on sides, lighter below, darkest at line of meeting with a yellow dorsal band which extends to tip of tail; a dark line from eye to nostril; sides of head light; legs brownish red mottled with lighter; top of head behind eyes much dotted with black; total length 81, head 11, body 40, tail 33.

Variation: A young female, U. Mich No. 54216, same data, differs in having 13 costal grooves; head width 5 in length from snout to vent; head length 3½ in length of body; no anal papillae; vomerine series separated from its fellow and from parasphenoids by ½ length of series; no enlarged teeth on premaxilla; darker below than described male save for throat and tail; total length 69, head 9, body 31, tail 29.

A young specimen, U. Mich. No. 54215, same data, has the appressed toes meeting; total length 29, head 4.5, body 14.5, tail 10.

The more usual count of costal grooves is 13. Most of the specimens seen are darker below than the described male. In many of the specimens there are distinct traces of a dorsolateral series of light spots. These take the form of downward projections of the dorsal

light stripe so that the spots would be half on the dark sides and show, and half on the light back and not show. Strangely enough the smallest specimen shows no trace of this presumably primitive marking. In 23 specimens in the Michigan collection 13 showed these traces of spots.

Habits: Noble (1925) says: "Mr. Phillips Putnam has sent me a cluster of eggs of this species which he found 'fastened together in a grape-like mass and attached to the stone by a string of elastic material.' The stone was in a damp situation and covered by moss."

Remarks: This species has no obvious allies in the genus and occupies a rather isolated position in it. It is remarkably distinct and resembles *intermedius* only superficially in size and in color.

Specimens seen 28, as follows:

Washington: Mt. Rainier Park 1 (Cal. Acad. Sci.); Marysville 1 (U. S. N. M. No. 52109); Lake Cushman, Mason Co. 1 (A. M. N. H. No. 17100); 6 miles above Lake Cushman 2 (M. C. Z. No. 6607-8); edge of Skokomish river at Devil's Staircase, Mason Co. 23 (U. Mich. No. 54213-31, 54233).

16. Washington State, showing localities for Plethodon vandykei.

PLETHODON INTERMEDIUS BAIRD

1867 *Plethodon intermedius* Baird, Proc. Acad. Nat. Sci. Philadelphia, p. 209; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 57; Cope 1883, Proc. Acad. Nat. Sci. Philadelphia, p. 23; 1889, Bull. U. S. Nat. Mus. 34, p. 145, f. 33; Van Denburgh 1916, Proc. California Acad. Sci. (4), 6, p. 218; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 25; Stejneger and Barbour 1917, Check List, p. 16; 1923, Check List (2), p. 11.

Type: U. S. N. M. No. 4732. Collected by John Xantus?

Type locality: Fort Tejon, California?

Range: Fraser River, British Columbia, to Salem, Oregon. Pacific Border Province.

Diagnosis: A *Plethodon* with light dorsal band; 14-15 costal grooves; vomerine teeth about 6 in series, not extending beyond nares.

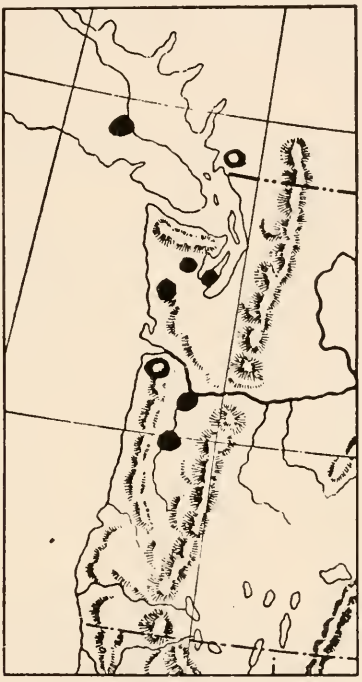
Description: U. S. N. M. No. 55372, adult male, Union Bay, Vancouver I; 15 costal grooves, 4 costal folds between appressed toes; head width 7½ in length from snout to vent; head length 4 in length of body; head a blunt oval; eye as long as its distance from tip of snout; snout somewhat swollen; outline of upper jaw concave as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove down from this behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 2, 5, 1 in order of length; fingers and toes slightly webbed at base; tail longer than body, terete; vent lined with papillae; vomerine teeth 6 in series, beginning behind inner edge of nares, running in and back, separated from its fellow by width of nares and from parasphenoids by 1½ width of nares; latter in an incompletely divided patch beginning at anterior ⅓ of eye-socket; black on sides, mottled below, a bright red dorsal band somewhat dirtied with black from head to tip of tail, a light line from eye to snout, a black diamond between eyes; total length 105, head 11.5, body 43.5, tail 50.

Variation: An adult female, U. S. N. M. No. 35852, Portland, Ore., differs in having the head width 8 in length from snout to vent; five costal folds between appressed toes; snout not swollen; outline of upper jaw straight as seen from side; no papillae in vent; vomerine teeth 7 in series, beginning behind middle of nares, separated from its fellow by width of nares, and from parasphenoids by twice that distance; dull dark brown above, mottled with lighter below; total

length 101, head 10, body 43, tail 48. This was the darkest specimen seen. The dorsal band may be yellow instead of red.

There may be 14 costal grooves as in the type, or 16 as in A. M. N. H. No. 15327 from Lake Cushman, Wash.

The largest female is A. M. N. H. No. 14471, from Hoquiam, Wash.; total length 108, head 11, body 54, tail 43. The smallest



17. Northwest coast, showing localities for Plethodon intermedius.

specimen seen is U. S. N. M. No. 35854, from Portland, Ore.; total length 47, head 7.5, body 25, tail 14.5. In this one the appressed toes are separated by 2 costal folds.

Most of the males have on each side of the vent a flap with free posterior edges.

Remarks: This is in general the largest and most primitive of the

group including also *dorsalis, cinereus,* and *elongatus.* It has fewer costal grooves, longer legs, and longer vomerine teeth than the other members of the group.

Specimens seen 22, as follows:

California: Ft. Tejon, Kern Co. 1 (U. S. N. M. No. 4732a, TYPE, locality probably erroneous, see Van Denburgh 1916).

Oregon: Portland 3 (U. S. N. M. No. 35852-4); Willamette Valley 1 (A. N. S.).

Washington: Gorse Cr., Kitsap Co. 1 (U. S. N. M. No. 62710); Lake Cushman, Mason Co. 8 (A. M. N. H. No. 15325-7, M. C. Z. No. 5928-32); Hoquiam 4 (A. M. N. H. No. 14470-3).

British Columbia: Union Bay, Vancouver I. 4 (U. S. N. M. No. 29616, 52108, 55372-3).

It has also been recorded from Salem, Ore. (Cope 1883); Fraser R., British Columbia (Boulenger 1882); and Olney, Clatsop Co., Ore. (Van Denburgh, ms.).

Note. The type of *Plethodon crassulus* Cope (1886, Proc. Amer. Phil. Soc., 23, p. 521), which is U. S. N. M. No. 9447 from California, is considered by Van Denburgh and by Stejneger (Van Denburgh 1916) to be a synonym of *P. intermedius.* Camp, who saw the type, considers it to be a specimen of *Aneides lugubris* (Grinnell and Camp, Univ. California Publ. Zoöl. 17, 1917, p. 134). I also have examined the type and agree with Camp.

Meek (1899, Zoöl. Series, Field Mus. N. H. 1, p. 232), speaks of *P. intermedius* and its larvae in the Olympic Mts. of Washington. The specimens upon which these remarks were based are actually examples of *Ambystoma macrodactylum.*

PLETHODON ELONGATUS VAN DENBURGH

1916 *Plethodon elongatus* Van Denburgh, Proc. California Acad. Sci. (4), 6, p. 216; Grinnell and Camp 1917, Univ. California Publ. Zoöl. 17, p. 134, f. 2; Stejneger and Barbour 1917, Check List, p. 15; 1923, Check List (2), p. 10; Storer 1925, U. California Publ. Zoöl. 27, p. 103.

Type: California Acad. Sci. No. 29096, collected by J. R. Slevin, May, 1911.

Type locality: Requa, Del Norte Co., California.

Range: Known only from type locality.

Diagnosis: A *Plethodon* with light, straight-edged dorsal band; 18 costal grooves, 6-7 costal folds between appressed toes; black beneath.

Description: M. C. Z. No. 7920, paratype, adult female, Requa, Del Norte Co., Cal.; 18 costal grooves; 7 costal folds between appressed toes; head width 7 in length from snout to vent; head length 3⅔; head oval; eye longer than its distance from the tip of the snout; outline of upper jaw concave as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind

18. Northern California, showing locality for Plethodon elongatus.

angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 2, 5, 1 in order of length, slightly webbed; tail slightly flattened, incomplete; vomerine teeth 6 in series, beginning behind inner edge of nares, running in and back, separated from its fellow by width of nares, and from parasphenoids by four times that distance; latter in a single patch; black above and below, dotted with light on throat; total length 81, head 11, body 40, tail 30 (incomplete).

Variation: A young specimen, Cal. Acad. Sci. No. 29101, same data, differs in having 6 costal folds between the appressed toes; third toe longer than fourth; sides and beneath black, throat whitish; a red dorsal stripe dying out at base of tail; this does not reach the lip between the nostrils; total length 43, head 7, body 23, tail 13.

Van Denburgh (1916) gives the color of the type as "blackish brown above and below; a broad, lighter brown, black-edged, dorsal band extending from snout to base of tail; lower surfaces sprinkled with small whitish dots, which become larger on the sides, gular region and chin." The measurements of the type were total length 117, head 11, gular fold to anus 38, front of anus to tip of tail 58.

Remarks: The closest ally of this species is unquestionably *cinereus*. The two are astonishingly alike. The belly color of *elongatus* is darker and more uniform, there is one less costal groove, the appressed toes are separated by one or two less costal folds. The vomerine teeth of *cinereus* are arranged more obliquely, usually fewer than 6 in a series, and the series is separated from its fellow by twice the width of the naris.

Specimens seen 2, as follows:

California: Requa, Del Norte Co. 2 (M. C. Z. No. 7920, Cal. Acad. Sci. 29101).

PLETHODON DORSALIS (COPE)

1889 *Plethodon cinereus dorsalis* Cope, Bull. U. S. Nat. Mus. 34, p. 138; Butler 1892, Journ. Cincinnati Soc. Nat. Hist. 14, p. 169; Hay 1893, Rep. Indiana Geol. 17, p. 34; McAtee 1907, Proc. Biol. Soc. Washington 20, p. 14; Banta 1907, Carnegie Inst. Pub. 67, p. 22; Hahn 1908, Proc. U. S. Nat. Mus. 35, p. 553.

1917 *Plethodon dorsalis* Stejneger and Barbour, Check List, p. 15; Dunn 1918, Bull. Mus. Comp. Zoöl. 62, p. 460; Löding 1922, Alabama Mus. Pap. 5, p. 12; Stejneger and Barbour 1923, Check List (2), p. 10.

1894 *Plethodon erythronotus* Garman, Bull. Essex Inst. 26, p. 38.

Type: U. S. N. M. No. 3776.

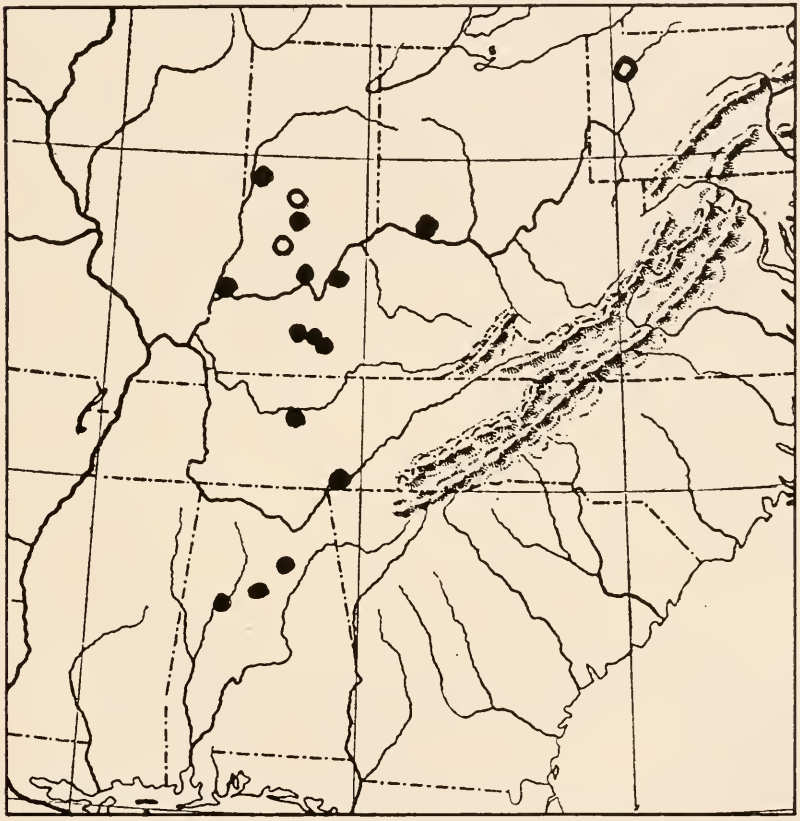
Type locality: Louisville, Ky.

Range: From Franklin, Venango Co., Pa., and Mecca, Parke Co., Ind., to Tuscaloosa Co., Ala. Interior Low Plateau; Appalachian Plateau, Cumberland Section.

Diagnosis: A *Plethodon* with 16-19 costal grooves, usually 16-17; usually a zigzag dorsal band; vomerine teeth 5 in series, not extending beyond nares.

Description: Adult male, Nashville, Tenn., my own collection; 18

costal grooves; 6 costal folds between appressed toes; head width 7⅓ in length from snout to vent; head length 4 in length of body; head oval; eye shorter than its distance from tip of snout; snout swollen, a tubercle below nostril; outline of upper jaw concave as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a



19. Middle West, showing localities for Plethodon dorsalis.

fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length, webbed at base, 1 entirely in web; toes 3, 4, 2, 5, 1 in order of length, webbed at base; vent papillate; tail longer than

body, terete; vomerine teeth 5 in series beginning behind middle of nares, separated from its fellow by width of nares, and from parasphenoids by twice that distance; latter in two patches beginning at middle of eyesocket; dark brown, gray below; a lighter irregular band on back from base of head onto tail; total length 87, head 9, body 37, tail 41.

Variation: A female, same data, has 19 costal grooves; 8 costal folds between appressed toes; head width 8; snout not swollen; no papillae in vent; total length 81, head 9, body 41, tail 31.

A young specimen, same data, is brownish black; below lighter, mottled with white; a zigzag stripe from base of head to base of tail; a straight stripe on tail; about 5 angular projections on dorsal stripe; a light canthal line.

The smallest specimen with the same data has 3 costal folds between the appressed toes.

Measurements of a series from Nashville follow:

Sex	*Total*	*Head*	*Body*	*Tail*	*Costal Grooves*	
♂	87	9	37	41	18	
♂	72	8	32	32	18	
♂	66	9	33	23	17	
♀	81	9	41	31	19	
♀	75	8	32	35	19	dark
♀	74	9	39	26	17	"
♀	70	9	34	27	18	"
♀	66	7	30	29	18	"
...	43	7	24	12	17	
...	36	5	16	15	17	

The dark specimens are quite different in appearance from the dark phase of *cinereus*. Thus the 75 mm. female of the above list is dull brown above, sides light and below gray; sides of base of tail mottled with black.

One specimen from Mammoth Cave, Ky. (M. C. Z. No. 1681), has a straight dorsal stripe, but it is much narrower than that of *cinereus* of equal size.

Habits: McAtee (1907) says that in Monroe Co., Ind., *cinereus* and *erythronotus* are common and that *dorsalis* is rare. "The form *erythronotus* is generally found under rocks and logs, in comparatively dry situations, along the sides of hills, particularly those with a south-

ern exposure. The other varieties, however, are most often found near water, at least, at the foot of the hill slopes. The form *cinereus* has often been taken from under stones on the edge of a creek, and two *cinereus* and one *dorsalis* were secured in Mayfield's Cave." There is of course here the possibility that his "*cinereus*" is the unstriped phase of *dorsalis*, in which case his remarks as to different habitat relationships would have some significance.

In Lawrence County, whence I have seen two striped *dorsalis* and one striped *cinereus*, Hahn (1908) found no striped *cinereus*. He found many unstriped specimens and speaks of "the sides and dorsum of the tail mottled with gray and brown," which would indicate that they were the unstriped form of *dorsalis*. Hence his remarks may well apply wholly to *dorsalis*. He says, "During October it was to be found under almost every log in the woods and also under the rocks near the cave entrances. With the approach of winter it was seen less frequently. The extraordinarily warm weather in early January brought it out again and I saw numbers from the 6th to the 8th of that month. From that time till April none were taken above ground. Some were found in a small cave on March 26. Early in April, when the temperature was much lower than during part of March, these salamanders suddenly became very abundant. They were to be seen in almost any part of the woods, and were especially noticeable about the entrance to the Twin Cave. Here they seemed to be migrating from the vicinity of the cave into the woods. In a few moments I found eleven of the animals hiding under stones on the bank, all within an area of a few square yards. Ten days later diligent searching in the same place failed to discover a salamander. However, they remained fairly common under old logs in the woods throughout early spring. During the summer none were found nor were the eggs or young seen.

"On several occasions I have heard salamanders of this species utter a faint squeak, not unlike that of a young mouse."

Some were found "25 feet below the surface, from which they were separated by smooth vertical walls, which would have to be scaled by the animals in escaping from the cave."

Remarks: Both the striped and unstriped individuals of this form can easily be separated on the grounds of color alone from the striped and unstriped individuals of *cinereus*. The differences in costal

groove count are difficult of application in individual instances. *Dorsalis* has usually one less groove than *cinereus;* and it also has a shorter tail, never longer than the head and body.

The unstriped phase is confined to the adults in *dorsalis,* and is really a breaking down and diffusion of the lateral dark stripe, so that the total amount of dark pigment seems the same in striped and unstriped individuals. In *cinereus* the unstriped form occurs among the youngest individuals, and represents an actual increase in amount of dark pigment. Unstriped *cinereus* are far darker than unstriped *dorsalis.*

The two occur together in Indiana. I have seen specimens of both from the following localities: Mecca, Parke Co. (striped of both species); Fort Ritner, Lawrence Co. (striped of both species) — (in these lots the *dorsalis* had 18 costal grooves and the *cinereus* 19); Posey Co. (unstriped of both species, the two *dorsalis* having 17 costal grooves and the six *cinereus* 18-20, four of them having 19). As aforestated they have both been recorded from Monroe Co.

I cannot see my way clear to do other than recognize *dorsalis* as a full species. Its range is somehow different from that of *cinereus,* a difference which is seen in the case of a few other forms such as *Lampropeltis getulus niger* and *Hyla phaeocrypta.*

Specimens seen 62, as follows:

Ohio: Ripley 1 (U. S. N. M. No. 3825).

Indiana: Mecca, Parke Co. 2 (M. C. Z. No. 7292-3); Ft. Ritner, Lawrence Co. 2 (M. C. Z. No. 7294-5); Wyandotte, Crawford Co. 1 (M. C. Z. No. 7298); Posey Co. 2 (M. C. Z. No. 7296-7).

Kentucky: Louisville 4 (U. S. N. M. No. 3776 TYPES); Mammoth Cave 29 (M. C. Z. No. 1681, U. S. N. M. No. 25310-11); Bee Spring 2 (M. C. Z. No. 2272, 4703); Glasgow Junction 1 (M. C. Z. No. 1885).

Tennessee: Nashville 12 (E. R. D.); Lookout Mt. 1 (U. S. N. M. No. 12702); Bellevue 1 (A. N. S.).

Alabama: Gallant, St. Clair Co. 1 (U. Ala.); Shoal Creek, Tuscaloosa Co. 1 (U. Ala.) University, Tuscaloosa Co. 1 (U. Ala.); Birmingham 1 (U. S. N. M. No. 51157).

It has also been recorded from Franklin, Venango Co., Pa. (Cope 1892); Bloomington, Ind. (Butler 1892); Mayfield's Cave, Monroe Co., Ind. (McAtee 1907); Mitchell, Lawrence Co., Ind. (Hahn 1908); and Hopkinsville, Ky. (Garman 1894).

PLETHODON CINEREUS (GREEN)

1818 *Salamandra cinerea* Green, Journ. Acad. Nat. Sci. Philadelphia, p. 356; Harlan 1826, same, 5, p. 330; Haldeman 1847, Proc. Acad. Nat. Sci. Philadelphia, p. 315.

1838 *Plethodon cinereus* Tschudi, Mém. Soc. Sci. Nat. Neuchâtel, p. 58; Baird 1849, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 285; Hallowell 1856, Proc. Acad. Sci. Philadelphia, p. 101; Verrill 1862, Proc. Boston Soc. Nat. Hist. 9, p. 197; Smith 1882, Ohio Geol. Surv., p. 725; Hay 1893, Rept. Indiana Geol., p. 33; Gaines 1895, Amer. Nat. 29, p. 55; Kingsbury 1895, Proc. Amer. Micr. Soc. 17, p. 282 (spermatheca); Cox 1898, Bull. Nat. Hist. Soc. New Brunswick 4, 16, p. 64; 1899, Trans. Roy. Soc. Canada (2), 5, p. 141; Moore 1900, Proc. Acad. Nat. Sci. Philadelphia, p. 618 (vertebrae); Montgomery 1901, same, p. 503 (habits); Preble 1902, N. Amer. Fauna 22, p. 134; Hay 1902, Proc. Biol. Soc. Washington 15, p. 125; Meek 1902, Zoöl. Ser. Field Mus. 3, p. 139; Montgomery 1903, Biol. Bull. 4, p. 259 (spermatogenesis); Stone 1903, Proc. Acad. Nat. Sci. Philadelphia, p. 538; Clark 1904, Rept. Michigan Acad. Sci. 4, p. 193; Ditmars 1905, Amer. Mus. Journ. 5, 4, p. 170, f. 6; Clark 1905, Rept. Mich. Acad. Sci. 7, p. 109; Stone 1906, Amer. Nat. 40, p. 160; McAtee 1907, Proc. Biol. Soc. Washington 20, p. 14; Nash 1908, Vert. Ontario, p. 7; Reed 1908, Amer. Nat. 42, p. 460 (erythrism); Kingsbury and Reed 1908, Journ. Morph. 20, p. 579, f. 6-7 (otic region); Piersol 1910, Trans. Canadian Inst. 8, p. 467 (habits); 1913, Nat. Hist. Toronto, p. 243; Surface 1913, Zoöl. Bull. Pennsylvania Dept. Agric. 3, 3-4, p. 93, f. 7, pl. 4, f. 2; Piersol 1914, Trans. Canadian Inst. 10, p. 121 (habits); Deckert 1914, Copeia 13; Shufeldt 1916, Aquatic Life 1, 6, p. 69; Patch 1917, Ottawa Nat. 32, p. 53; Stejneger and Barbour 1917, Check List, p. 15; Murphy 1917, Copeia 51, p. 105 (habits); 1918, Copeia 52, p. 8 (food); Dunn 1918, Copeia 53, p. 19; 1918, Bull. Mus. Comp. Zoöl. 62, p. 462; Evermann 1918, Copeia 61, p. 82; Speck 1919, Copeia 70, p. 46; Wright and Moesel 1919, Copeia 72, p. 64; Dunn 1920, Proc. Biol. Soc. Washington 33, p. 132; Potter 1920, Copeia 82, p. 40; Noble 1921, Bull. Amer. Mus. Nat. Hist. 44, p. 5 (septomaxilla); Ortenburger 1921, Copeia 99, p. 73; Wright and Simpson 1921, Canadian Field Nat. 34, p. 141; Brimley 1922, Copeia 109, p. 63; Bishop 1923, Copeia 118, p. 66; Breder and Breder 1923, Zoologica 4, 1, p. 14; Stejneger and Barbour 1923, Check List (2), p. 10; Brady 1924, Copeia 130, p. 55; Bishop 1924, Bull. New York Mus. 253, p. 89; Pope 1924, Amer. Mus. Nov. 153, p. 2; Crozier 1924, Amer. Nat. 58, p. 480; Bishop 1925, Copeia 139, p. 9; Fowler 1925, Copeia 145, p. 58, 62; Edgeworth 1925, Journ. Anat. 59, p. 229, f. 43-4 (chrondocranium); Noble 1925, Journ. Morph. 40, p. 387, f. 310 (skin).

1869 *Plethodon erythronotus cinereus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 99; Smith 1879, Science News; Brimley 1907, Proc. Elisha Mitchell Sci. Soc. 23, p. 154.

1883 *Plethodon cinereus cinereus* Davis and Rice, Bull. Chicago Acad. Sci. 1, 3, p. 26; Cope 1889, Bull. U. S. Nat. Mus. 34, p. 134; Morse 1901, Ohio Nat. 1, p. 115; Britcher 1903, Proc. Onondaga Acad. Sci. 1, p. 120; Henshaw 1904,

Occ. Pap. Boston Soc. Nat. Hist. 7, 2, p. 3; Morse 1904, Ohio Acad. Sci. 4, p. 111; Drowne 1905, Mon. Roger Williams Park Mus. 15, p. 17.

1818 *Salamandra erythronota* Green, Journ. Acad. Nat. Sci. Philadelphia 1, p. 356 (New Jersey); Harlan 1826, same, 5, p. 329; Holbrook 1838, N. Amer. Herp. 3, p. 113, pl. 27; Storer 1839, Rept. Massachusetts, p. 245; Holbrook 1842, N. Amer. Herp. (2), 5, p. 43, pl. 11; DeKay 1842, Zoöl. New York 3, p. 75, pl. 16, f. 38; Thompson 1842, Hist. Vermont, p. 119; Linsley 1844, Amer. Journ. Sci. Arts 46, p. 49; Haldeman 1847, Proc. Acad. Nat. Sci. Philadelphia, p. 315; Storer 1852, Proc. Boston Soc. Nat. Hist. 4, p. 149; Fogg 1862, Proc. Portland Soc. Nat. Hist. 1, p. 86; Jones 1865, Proc. Nova Scotia Inst. Sci. 1, 3, p. 126; Provancher 1874-5, Nat. Canadien 6-7.

1843 *Sauropsis erythronotus* Fitzinger, Syst. Rept., p. 33.

1849 *Plethodon erythronotus* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 285; Storer 1852, Proc. Boston Soc. Nat. Hist. 4, p. 138; Hallowell 1856, Proc. Acad. Nat. Sci. Philadelphia, p. 11; 1856, same, p. 101; 1858, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 343; Putnam 1865, Proc. Boston Soc. Nat. Hist. 9, p. 173 (habits); Allen 1868, Proc. Boston Soc. Nat. Hist. 12, p. 198; Cope 1869, Proc. Acad. Nat. Sci. Philadelphia, p. 99; Allen 1870, Proc. Boston Soc. Nat. Hist. 14, p. 260; Smith 1879, Science News; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 57; Davis 1884, Proc. Nat. Sci. Ass. Staten I. 1, p. 13; Fisher 1887, Amer. Nat. 21, p. 672; Cope 1889, Bull. U. S. Nat. Mus. 34, pl. 19, f. 4-6; Müller 1889, Verh. Ges. Basel 8, p. 687; Worthen 1891, Vert. Hanover, p. 61; Blatchley 1891, Journ. Cincinnati Soc. Nat. Hist., p. 25; Butler 1892, Journ. Cincinnati Soc. Nat. Hist. 14, p. 170; Wilder 1894, Anat. Anz. 9, p. 216 (lunglessness); Gaines 1895, Amer. Nat. 29, p. 55; Sherwood 1895, Proc. Linn. Soc. New York 7, p. 21; Rhoads 1895, Proc. Acad. Nat. Sci. Philadelphia, p. 402; Mackay 1896, Proc. Nova Scotia Inst. Sci. 9, p. 53; Murray 1897, Anat. Anz. 13, p. 663 (vertebrae); Cox 1898, Bull. Nat. Hist. Soc. New Brunswick 4, 16, p. 64; 1899, Ottawa Nat. 13, p. 194; Allen 1899, Proc. Boston Soc. Nat. Hist. 29, p. 75; Ruthven 1904, Rep. Michigan Acad. Sci. 6, p. 188; 1906, Rept. Michigan Geol. 1905, p. 107; Brimley 1907, Proc. Elisha Mitchell Sci. Soc. 23, p. 154; Fowler 1907, Rept. New Jersey Mus. 1906, p. 55; 1908, same, 1908, p. 393; Reed and Wright 1909, Proc. Amer. Phil. Soc. 48, p. 403; Hurter 1911, Trans. Acad. Sci. St. Louis 20, p. 81; Ruthven 1911, Rept. Michigan Acad. Sci. 12, p. 59; 1911, Geol. Biol. Surv. Michigan 4, p. 257; Brimley 1912, Proc. Biol. Soc. Washington 25, p. 137; Thompson and Thompson 1912, Rep. Michigan Acad. Sci. 14, p. 216; 1912, Publ. Geol. Biol. Surv. Michigan 10, p. 32, pl. 1, f. 2, pl. 2, f. B; Keim 1914, Copeia 2; Street 1914, Copeia 4; Barbour 1914, Copeia 10 (erythrism); Brimley 1915, Journ. Elisha Mitchell Sci. Soc. 30, p. 5; Dunn 1915, Copeia 16; Gaige 1915, Occ. Pap. Mus. Zoöl. U. Michigan 17, p. 4; Thompson 1915, same, 18, p. 3; Fowler 1915, Proc. Delaware Co. Inst. Sci. 7, p. 8; Evans 1915, Proc. U. S. Nat. Mus. 49, p. 352; Fowler 1915, Copeia 22, p. 38; Keim 1915, Copeia 24, p. 51; Dunn 1915, Copeia 25, p. 63; 1916, Copeia 28, p. 22; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 24; Fowler 1917, Copeia 40, p. 14; Mattern

and Mattern 1917, Copeia 46, p. 64; Dunn 1917, Bull. Amer. Mus. Nat. Hist. 37, p. 606; Higgins 1921, Illinois Biol. Mon. 6, p. 25 (Nasal capsule); Emmel 1924, Amer. Journ. Anat., p. 351 (erythrocytes).

1850 *Ambystoma erythronotum* Gray, Cat. Batr. Grad. Brit. Mus., p. 37.

1854 *Plethodon erythronotum* Duméril and Bibron, Erp. Gén. 9, p. 86.

1883 *Spelerpes erythronota* Kennicott, Trans. Chicago Acad. Sci. 1, p. 144.

1889 *Plethodon cinereus erythronotus* Cope, Bull. U. S. Nat. Mus. 34, p. 135, f. 30; Butler 1892, Journ. Cincinnati Soc. Nat. Hist. 14, p. 170; Morse 1901, Ohio Nat. 1, p. 115; Clark 1904, Rept. Michigan Acad. Sci. 4, p. 193; Henshaw 1904, Occ. Pap. Boston Soc. Nat. Hist. 7, 2, p. 3; Morse 1904, Ohio Acad. Sci. 4, p. 111; Ditmars 1905, Amer. Mus. Journ. 5, 4, p. 171, f. 7; Drowne 1905, Mon. Roger Williams Park Mus. 15, p. 17; Kingsbury and Reed 1908, Anat. Rec. 2, p. 82 (otic region); Deckert 1914, Copeia 13; Brimley 1922, Copeia 107, p. 47.

1903 *Plethodon cinereus erythronota* Britcher, Proc. Onondaga Acad. Sci. 1, p. 120.

1833 *Salamandra cinera* Smith, in Hitchcock, Geol. Massachusetts, p. 552; Sager 1839, Senate Doc. Mich., p. 294.

1833 *Salamandra erithronota* Smith, in Hitchcock, Geol. Massachusetts, p. 552.

1854 *Salamandra puncticulata* Valenciennes in Duméril and Bibron, Erp. Gén. 9, p. 87.

1858 *Salamandra agilis* Sager, Penn. Journ. Med., p. 429 (Detroit, Mich.).

Type: Not known to exist.

Type locality: New Jersey.

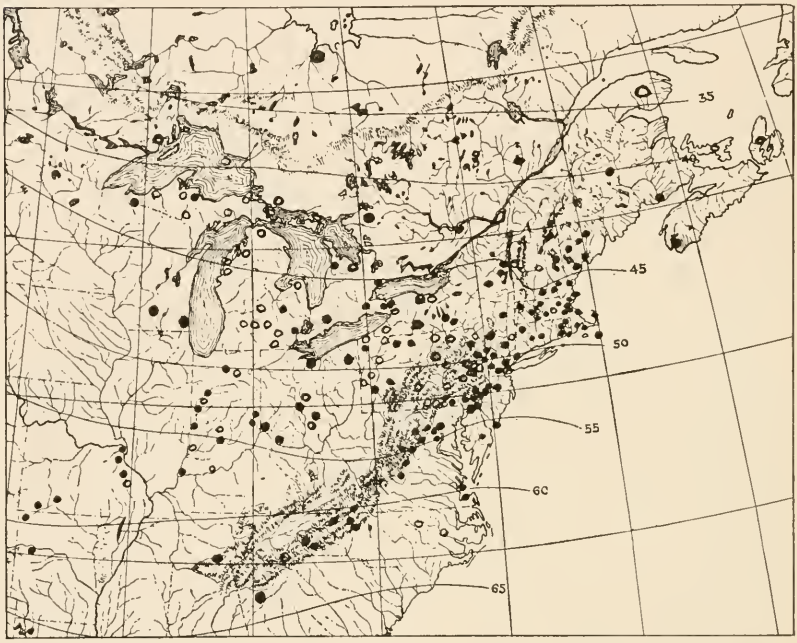
Range: From Gaspé, Prince Edward I., Cape Breton I., Hudson's Bay and Fort William, Ont., to Dallas, Ga., and Roger, Arkansas.

Diagnosis: A *Plethodon* with 17-21 costal grooves (usually 19-20); either a straight-edged red dorsal band, or rather uniformly dark above; vomerine teeth 5 in series, not extending beyond nares; mottled gray and white below.

Description: Adult male, Northampton, Mass., Smith College collection; 19 costal grooves; 7 costal folds between appressed toes; head width 7 in length from snout to vent; head length 4 in length of body; eye shorter than its distance from tip of snout; snout swollen, a tubercle below nostril; outline of upper jaw concave; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind gular fold; limbs weak; fingers 3, 2, 4, 1 in order of length, webbed at base, 1 entirely in web; toes 3, 4, 2, 5, 1 in order of length, webbed at base; tail shorter than body, terete; vent papillate; vomerine teeth 5 in series beginning behind inner edge of nares, separated from its fellow by width of nares, and from parasphenoids by twice

that distance; latter in two patches beginning at middle of eyesocket; premaxillary teeth enlarged, forward in position, piercing lip; black on sides, and on sides and top of tail, gray and white mottled below; dorsal surface a light band with straight edges; total length 82, head 9, body 38, tail 35.

Variation: A female, same data, has tail as long as head and body; 20 costal grooves; 8 costal folds between appressed toes; snout not



20. Eastern North America, showing localities for Plethodon cinereus.

swollen; no papillae in vent; vomerine teeth 7 in series, beginning behind middle of nares; premaxillary teeth not enlarged; much lighter in color than described male; a bright dorsal stripe from base of head to half way down tail; total length 88, head 9, body 35, tail 44.

A young specimen, same data, has 19 costal grooves; 3 costal folds between appressed toes; light brown on sides; light below; almost no black pigment on dorsum from base of head to tip of tail; top of snout

light; between and back of eyes darker; total length 26, head 4, body 13, tail 9.

A male of the dark phase, same data, has a black tail; black above and on sides; below light gray mottled with white, especially on throat; total length 79, head 9, body 36, tail 34.

As usual in salamanders the legs are proportionately longer in young than in adults, and longer in males than in females.

The dark phase is not a matter of age or sex. A young specimen of the dark phase, same data, has 5 costal folds between appressed toes; total length 47, head 6, body 21, tail 20. A female of the dark phase, same data, has 8 costal folds between appressed toes, total length 86, head 8, body 35, tail 43.

The amount of black pigment in the light phase seems to increase with age, especially on the tail. Few old individuals can be found with the dorsal stripe extending to the tip of the tail. Reed (1908), Reed and Wright (1909), and Barbour (1914), mention specimens which are completely red. These differ from the red-striped ones only in absence of black pigment. This suggests the possibility that red pigment may underlie the black even in the dark phase.

The costal grooves are 20 if one immediately over the arm is counted as the first, and both forks of a forked one in front of the leg are counted. Not counting these would make 18. Rarely there is actually one more making 21 counting all and 19 omitting the end ones, or one less making 19 counting all and 17 omitting the end ones.

I do not find any geographical variation in costal groove count. There is some localization apparent in the distribution of the red-striped and dark phases. Thus of 48 specimens I took at Linville in 1916, only 2 were dark. Breder and Breder (1923), however, say that at Beaver Creek, Ashe Co., only about 40 miles away the dark phase was common and the striped phase very rare. Hurter (1911) says that no dark ones have ever been taken in Missouri. Cox (1898) says that the dark phase is not found on the North Shore of New Brunswick. Usually, however, the two phases are equally common and probably correspond in biological value to the red and gray phases of many birds and mammals.

Habits: Putnam (1865) first described the eggs of this animal. He found them at Warwick, Mass., on the 26th of August, at Fitchburg, Mass., in June, and in the White Mts., N. H., in August.

Montgomery (1901) gave some account of the eggs and the early development.

The best accounts are those of Cochran (1911), and of Piersol (1910, 1914), and from these the following passages are quoted. Cochran worked in the vicinity of Worcester, Mass., and the following observations apply to that region:

"During the summer of 1910, eggs of the red-backed salamander were found first on July 5. From then until the latter part of August eggs were found. They are in the ordinary habitats beneath stones and logs. The stones are always those deeply set into the ground in close contact with it, probably because there the atmosphere is moist.

"The eggs, from five to nine in number, are in grape-like clusters attached to the under surface of stones or logs, unlike those of *Spelerpes* and *Autodax lugubris* Hallow, which are attached singly. One pedicel supports a cluster. This pedicel is tough, white, and seems made of separate threads closely stuck together; it resembles the tough, outer membrane covering each egg. There is no uniform arrangement of eggs in the cluster.

"The egg of the red-back is spherical, 5 mm. in diameter, has a prominent yolk and considerable transparent jelly. On the outside is a thin, tough envelope to which particles of earth and leaves readily adhere.

"With each cluster of eggs, there was always one or two adults. Dissection showed that when there was one only, it was a female, when two, they were male and female. There is, accordingly, no evidence that the male takes any active part in the care of the eggs in this species. The egg cluster is always so attached that one of the adults may coil its body about it. Sometimes a crevice beside a rock is utilized, the eggs, attached by the pedicel to a root or stone above, swinging loose. This brooding by the adults doubtless serves the double purpose of providing moisture and securing protection from insects."

By far the best general account is given by Piersol (1910) from which I quote the following:

"In handling living specimens it will frequently happen that the end of the tail will apply itself closely to a finger in a semi-circular loop, and hold thus for a few seconds. This power may perhaps be

regarded as the first step in the development of a prehensile tail such as is described for *Autodax* (Ritter & Miller, '99).

"Two habits of *Plethodon* deserve notice as being of rare occurrence among Urodeles. When excited it occasionally aids its progress by leaping. In such cases as have been observed under conditions that admitted measuring the length of the leap it has been found about equal to the length of the animal's body. If the animal is running on a rather even surface it lands on its feet and continues the run having gained by its leap; but it will just as readily leap into difficulties. Held in the open hand it will frequently leap off, no matter what may be the height of the hand above the ground. In jumping the back is slightly arched and the front limbs with most of the trunk are raised in the air to about the height of one centimetre; then with a snap the tail is slapped against the surface over which the animal is moving and the body sharply straightens and shoots forward. The whole movement is so rapid that it cannot be distinguished with certainty whether the limbs aid in the leap. Two things suggest that they do; it is difficult to imagine a force to raise the anterior part of the body to the height it attains if it does not chiefly lie in a spring given by the anterior limbs. The posterior limbs are even stouter and are in a good position to aid in the forward propulsion. The young as well as adults possess this power of leaping, indeed the only specimen observed to give a succession of leaps, three in fact, was one of 24 mm. The explanation of the greater development of the posterior limbs in the later larval stages, noted by Montgomery ('01), may lie in this habit. In this connection Cope ('89) says: 'It frequently climbs to the summit of low vegetation, from which it springs by a sudden straightening or curvature of the body, as the case may be, in the manner of a caterpillar.' The curvature and straightening in leaping are evident; the climbing of low vegetation to leap from it has not come under observation.

"The second noteworthy habit is also connected with escaping enemies. *Plethodon* will sometimes break off a portion of its tail. Two things suggested the existence of this habit before it was actually observed. In searching for Plethodons in decaying logs not infrequently as the covering is lifted the animal will be found crawling stealthily away from the bit of tail that is making itself very conspicuous by its violent movements. This will occur at times when so

little force has been used in picking apart the log that it is difficult to conceive how the piece could have been broken or pinched off. Again about 10% of all specimens found show the end of the tail in the process of regeneration, raising the suspicion that it is a mutilation out of the ordinary. On one occasion when a young *Plethodon* had been repeatedly touched by a small rod it suddenly gave a jump breaking off at the same time the terminal third of its tail. Two adults while being held lightly by the tail cast off a portion of it, the separation occurring in the part grasped and leaving in the one case a stump 1 cm. and in the other 1.75 cm. long, measuring from anus to end of stump. In no case observed has the length of the tail retained been less than .5 cm.; it was usually more. There does not seem to be any place where separation greatly tends to occur. Incomplete separation has also been noted, the vertebrae and muscles separating but the skin failing to break; this causes a slight grooving of the tail as though an invisible thread were tied around, compressing it. Longitudinal sectioning was used to examine both proximal and distal pieces in those cases that occurred under observation, and the relation of parts in the wound was found to be as follows: Separation of the vertebral column occurs between vertebrae; this is the condition also in *P. oregonensis* (Hubbard, '03). In the muscle the myomeres are not broken but separation occurs in the myocomma opposite the middle of the last vertebra retained. The skin, however, does not break here but at the myocomma opposite the middle of the first vertebrae of the piece cast off. Two things are accomplished by this: first, the wound that now terminates the animal's tail is protected by the extra length of skin which collapses laterally upon it and almost covers it in. Second, on the piece cast off considerable raw surface is left exposed, the irritation from which is doubtless largely responsible for the rapid contortions that occur. The piece must play an important part in the protective device for its violent movements would draw the attention and invite the first attack of an enemy."

"There is considerable latitude for a Urodele in the time at which egg-laying occurs. The earliest date on which eggs have been found was June 16th — 3 clusters, the eggs in early stages of segmentation; the latest is July 3rd — 1 cluster, in the same condition. The difference is not due entirely to different seasons being early or late, nor to one bit of woodland being better sheltered and warmer than another,

for clusters of eggs with the females on guard and other females with the season's eggs yet in the ovaries have been found in the same log on the same day. The date, Oct. 25th, given by Sherwood ('95) for the finding of eggs of *Plethodon* is not accompanied by any description of them; and its exceptional lateness leaves the meaning of his observation doubtful.

"The eggs of the one individual seem to be deposited all at the one time. No female was found guarding a cluster of eggs having also any in the oviduct or even in the ovary that were nearly full size. It is, however, not at all uncommon to find an egg in one ovary about half-size; this should be associated with the small egg of some bunches described below and considered as one that should have been laid this season but which, having failed to develop its proper amount of yolk, is retained in the ovary.

"As a situation for the eggs marked preference is shown for logs almost entirely embedded in the humus, logs that have decayed to a point where the substance is friable with large cracks running lengthwise. In one of these cracks the eggs are hung from the roof like a little bunch of grapes. Rarely a similar cavity within a decaying stump is selected. All the localities in which *Plethodon* has been found contain conifers and almost without exception it is in coniferous wood that the eggs have been found; though the adults may be found plentifully in wood of all kinds. Usually the eggs are placed from three to five inches beneath the surface of the log, at which depth its substance is constantly moist, and it can well be imagined that the air is saturated with water vapor. They are always accompanied by the female and if in exposing them she has not been alarmed she will be found holding the dorsal surface of her head and neck against the under side of the bunch. That it is the female that remains on guard was determined by the dissection of over twenty specimens. In only one case was a male found by eggs and then in company with a female; the eggs were several days advanced in development and the presence of the male was perhaps merely an accident. Cope ('89) and Montgomery ('01) speak of finding the animals and their eggs under stones but if the above mentioned shelters are available they are always preferred. Wilder ('94) notes that the adults are seldom to be found under stones. Sherwood ('95) gives the habitat as beneath logs and stones, while

the eggs are to be found in damp moss and beneath the bark of decaying stumps."

"The number of eggs in a cluster varies from three to twelve. The number of ovarian eggs in advanced condition, in specimens taken just before the egg-laying season is also within these limits and the length of the incubation precludes a second brood in the one year. Consequently the preservation of the species must depend upon the larval stages being so perfectly adjusted to surrounding conditions that the mortality is very small, rather than — as is the case with most Urodeles — upon the production of large numbers of young. The slender and almost cylindrical form of body (the proportion of length to greatest breadth being fourteen to one) in an animal so small, along with the necessity for producing eggs containing a large amount of yolk are doubtless factors determining the small number of eggs; another will be mentioned later."

"Each egg is surrounded by a series of mucous spheres as is customary in Urodeles. In their natural condition the number of these is rather difficult to determine, but after soaking a few minutes in water they swell somewhat and the following is plainly seen: — an innermost sphere very close to the surface of the egg; a second enclosing this but separated from it by a greater interval than that between the innermost sphere and the egg; occasionally this sphere is represented by two, one of them fitted very closely around the other. The outermost sphere — usually the third — fuses with the outermost spheres of neighboring eggs at all points of contact. On its surface are threads and bands of a milky white mucus which seems tougher than the rest, which is transparent; these are especially numerous between eggs and at the upper part of the bunch where several uniting form the stalk by which the cluster is suspended. This mode of attachment is probably derived from one originally like that of *Desmognathus* (Wilder '99) in which each egg of the cluster is independent of all the rest and has its own cord joining it to the common stalk. The tension of the envelopes, especially the innermost, is needed to preserve the spherical shape of the egg. These envelopes are very tough; a weak hypochlorite solution will soften them so that they can be removed, but when their support is gone the egg, even in water, flattens until the vertical diameter is little more than half the transverse. In the younger stages it is therefore neces-

sary to fix and harden the egg first and remove the membrane later; they should be removed as soon as possible, for if left around the egg the latter will in time disintegrate. The method devised by Morgan ('91) has proved the most satisfactory."

"As development proceeds the amount of fluid between the egg and the innermost sphere increases markedly, thus relieving the growing embryo from pressure.

"The eggs vary from 3.5 to 4.5 mm. in diameter. In many of those bunches which contain several eggs there is one egg considerably smaller than the others; with this exception there is great uniformity in the size of the eggs of the one cluster. The considerable variation noted above exists between the eggs of different clusters.

"The colour of the egg is a very pale yellow, a tint due to the yolk for no pigment is present. The upper part of the egg being the more free from yolk is almost white. Variation exists in the tint of the eggs of different clusters, the range being between very pale cream and light orange-yellow."

"Escape from the mucous envelope occurs when the larva has reached the length of 20 to 25 mm.; this is about the first week of September. The outer larvae of a cluster escape first but remain with the mother beneath their less developed brethren. Respiration is now more perfect in these; in a few days their gills have disappeared and they also escape. However, the interval does not suffice to bring them so far on in development as were the outer ones when they escaped; they have absorbed less yolk and are shorter. They also seem unfit to come in competition with their more favored brethren of the outside of the bunch of eggs, their movements being comparatively feeble and ineffective; many of them probably die. Thus is supplied another factor tending toward the production of small numbers of large eggs; for those young will be best fitted for life that come from broods where all the nourishment available as yolk is divided among but few eggs, so few that none are crowded into the centre of the cluster.

"The family does not scatter at once, an unusual thing among Urodeles that have attained their adult form, but accompanied by the mother, perhaps led by her, the brood leaves the interior of the log to live beneath stones, fragments of wood or bark, lying on the surface of the ground, or even among layers of mouldering leaves. If not disturbed when uncovered the young will be found in contact with the

body of the mother, probably to obtain moisture; for the localities in which they now are contain little moisture at this season of the year. The families do not hold together for long. In the latter part of September a few solitary young will be found and early in October all the broods seem to have broken up. The rate of growth in *Plethodon* must vary enormously in different individuals, for at this season it is easy to collect a series beginning with young accompanying the mother and ending with full grown specimens, the increase in size being so gradual that it is impossible to draw with certainty a line between this year's and last year's broods. Apparently the ability to withstand the winter is independent of size for early in May an occasional specimen will be found that is little larger than the young at the time they escape from the egg — that is less than 30 mm. in length."

Piersol in a later paper (1914) describes the actual egg-laying. Some of his observations are here set down:

"Case I. On one occasion the actual extrusion of the eggs was observed. The female had been placed when captured in a small glass jar along with fragments of the log in which she was found; and the jar with others containing eggs was carried back to the laboratory in a small bag. Chiefly for the sake of the eggs which are very delicate the bag was guarded from shocks as far as possible, then for another hour it stood unopened. On removing the jar from the bag it was seen that the egg-laying had just begun, fortunately in such a position that all its details could be observed. The lips of the cloaca are pressed against the surface from which the eggs will eventually hang and a small quantity of mucus is extruded and adheres firmly to it. This much had been completed before observation began so nothing can be said as to the interval that then elapses before the first egg is laid. The extrusion of each egg occupies about twenty seconds and an interval of five to ten minutes occurs before the next appears. The first three eggs were laid in contact with the mucus above mentioned; the fourth, and last, adhered to them in turn through the stickiness of the egg-envelopes. As the female did not move during the entire process, all the eggs were laid at the same point, each egg as it came crowding the preceding ones aside, thus making sure of being in contact with them. For over an hour after the last egg was laid the

female did not change her position; during the next hour she left the eggs for a few minutes, then returned and coiled herself about them.

"Case II. In examining a terrarium on one occasion there was uncovered a female that had evidently just completed the extrusion of the eggs. Two eggs, approximately spherical, were in contact and cohering slightly; four other eggs, each more or less elongated, were lying separated from each other by intervals of about one-quarter of an inch; none of them were suspended. Evidently under the somewhat unnatural conditions the female had moved after the extrusion of each of the last five eggs. Case III. In picking apart a decaying log there were exposed on one occasion a female and four eggs. One of these lay by itself, markedly elongated; the other three were in contact, two of them somewhat elongated, the third apparently spherical. All four were lying on the floor of the cavity, which fortunately had been opened from the side. Examination of the female revealed the existence of four eggs in the posterior parts of the oviducts. Evidently the egg-laying process had been interrupted by the opening up of the nesting-chamber.

"These last two cases have been selected from among a few of the same general character because they differ from the rest in that the eggs were not suspended. In opening up logs a few clusters have been found unattached. At first, in such cases, it was taken for granted that the opening up of the nesting-chamber had involved the loosening of the eggs. Since attention has been directed to the possibility of a cluster not having been attached, two such have been found under circumstances that would seem to preclude the idea of their having been torn from their attachment. In neither of these two cases could a stalk attached to the cluster be found. It would seem that occasionally the tendency to reduce the amount of material devoted to forming stalks for the eggs goes so far as to eliminate even the stalk of the first egg. No exact count has been kept of the number of such cases as compared with the normal, attached ones, but the impression left is that it is very small.

"As might be concluded from Case I, an examination of the relation of the stalk to the eggs shows that it does not come from any one particular egg, but from a quantity of mucus that adheres to the outer envelope of certain of them; the impression given is that of a material poured onto the bunch, part of it being drawn out to form the stalk.

As is the usual case among Urodeles the outer envelope of each egg is of a much more sticky mucus than the inner ones. *Plethodon* is peculiar in having this outer layer unusually thin, and in depositing a still more sticky mass of mucus before the egg-laying proper begins."

In Michigan the eggs have been found on July 6, 18 (Potter 1920), and Aug. 10 (Gaige 1915); and in Pennsylvania Aug. 3rd (Bishop 1915).

Surface (1913) gives a list of foods found in the stomachs of 260 specimens "principally snails, earthworms, spiders, mites, thousand-legged 'worms,' insect larvae and adult insects, of which ants formed a large part."

Murphy (1918) has a note on the food, and (1917) a note on the jumping ability.

Remarks: This very common form is allied to *dorsalis* and to *elongatus*. Its relationships to *dorsalis* are fully discussed under that species. It is geographically isolated from *elongatus* and differs in its mottled and lighter belly. The specimen from Mississippi constitutes an isolated record. The range of *cinereus* is largely northern and seems to enclose the range of *dorsalis* on three sides.

Specimens seen 1,258, as follows:

Canada: Yarmouth, Nova Scotia 1 (M. C. Z. No. 8519); St. John's, New Brunswick 25 (M. C. Z. No. 1187, 1236, 4661); Lac au Sables, Quebec 1 (A. N. S.); Hudson's Bay 4 (U. S. N. M. No. 5963); Ontario, Toronto 1 (Roy. Ont. Mus. No. Z202); Ottawa 3 (E. R. D.); London 2 (Roy. Ont. Mus. No. 2208); St. Catherines 17 (U. S. N. M. No. 4729, 4828, 4829); Bruce Co. 2 (U. S. N. M. No. 57099-100); South of Highlands 4 (U. S. N. M. No. 5375); Bryron 2 (Roy. Ont. Mus.); Trout Cr. 5 (Field No. 884); York Mills 2 (Roy. Ont. Mus. No. 2201).

Maine: Mars Hill and Blaine 1 (Portland No. 544); Waterville 1 (M. C. Z. No. 2104); Manchester 12 (Bowdoin No. 184-5, 228, Pope 13, 34); Matinicus 6 (Portland No. 550-5); Hog I. 1 (U. S. N. M. No. 39106); Treat I. 5 (M. C. Z. No. 1174, 1178, Bowdoin No. 224); Big Babson's I. 9 (U. S. N. M. No. 24094-102); Lower Babson's I. 1 (U. S. N. M. No. 39100); Oxford 2 (Portland No. 545-6); Brownfield 3 (Portland No. 547-9); Topsham 4 (Bowdoin No. 74); Brunswick 16 (Bowdoin No. 45, 59, 108, 124, 126, 137, 205); Westbrook 1 (Portland No. 633); Freeport 1 (Bowdoin No. 66); Portland 2 (U. S. N. M. No. 44174-5); Falmouth 4 (Portland No. 538-41); West Scarboro 2 (Portland No. 542-3); Rangeley 1 (M. C. Z. No. 2106).

New Hampshire: Glen House, White Mts. 1 (M. C. Z. No. 1169); Milan 2 (M. C. Z. No. 1190); Exeter 8 (M. C. Z. No. 1191); Manchester 1 (Manning); Amherst 1 (M. C. Z. No. 1189); Peterboro 2 (E. R. D.).

Massachusetts: Gloucester 1 (M. C. Z. No. 1386); Beverly 5 (M. C. Z. No. 4726-30); Lynn 2 (M. C. Z. No. 1691); Boston 10 (M. C. Z. No. 1819, U. S. N. M. No. 13410-1); West Roxbury 6 (M. C. Z. No. 1185, 1821); Mattapan 1 (M. C. Z. No. 1851); Medford 1 (M. C. Z. No. 1183); Arlington 1 (M. C. Z. No. 4986); Woburn 1 (M. C. Z. No. 1186); Middlesex Fells 1 (E. R. D.); Cambridge 12 (M. C. Z. No. 4427-38); Malden 1 (M. C. Z. No. 1430); Sherborn 2 (M. C. Z. No. 2004); Newton 15 (M. C. Z. No. 1910, 2300); Bedford 2 (M. C. Z. No. 1179); Hudson 2 (M. C. Z. No. 1180); Cohasset 1 (M. C. Z. No. 3527); Milton 4 (Portland No. 45); Blue Hill 1 (E. R. D.); Marion 10 (E. R. D.); Wareham 4 (M. C. Z. No. 10209-12); Wood's Holl 1 (U. S. N. M. No. 9258); Harwichport 2 (E. R. D.); Cape Cod 7 (M. C. Z. No. 1181); Forest Hills 1 (Boston No. 587); Tuckernuck I. 1 (M. C. Z. No. 2286); Nantucket 2 (A. N. S. No. 17282-3); Berlin 3 (M. C. Z. No. 1170); Westboro 10 (M. C. Z. No. 4417-26); Warwick 6 (M. C. Z. No. 1182); Mt. Toby 42 (S. C. E. R. D.); Ware 1 (M. C. Z. No. 1172); Palmer 1 (E. R. D.); Springfield 31 (Springfield, M. C. Z. No. 2067, 4533-9, 4611-3); Northampton 11 (E. R. D.); Mt. Tom 10 (E. R. D.); Florence 5 (E. R. D.); Williamsburg 7 (E. R. D.); Williamstown 1 (M. C. Z. No. 1175); Windham 9 (M. C. Z. No. 2068); Feltonville 2 (M. C. Z. No. 1177); Hampden Co. 1 (U. S. N. M. No. 57096); no locality 3 (A. N. S. No. 1187-9).

Rhode Island: Hanging Rock, Middletown Township 3 (U. S. N. M. No. 28755-7); Diamond Hill 1 (S. C.); East Greenwich 1 (Boston); Providence 1 (Roger Williams Park Mus.); Charlestown 1.

Connecticut: Westfield 1 (Wesleyan No. 592); Middletown 4 (Wesleyan No. 273, U. S. N. M. No. 9994); Norfolk 5 (U. S. N. M. No. 13570); Cos Cobb 1 (U. S. N. M. No. 36450); Meriden 1 (Wesleyan No. 552).

New York: Westport 20 (U. S. N. M. No. 3758); Adirondack 1 (U. S. N. M. No. 3807); Piseco 1 (U. S. N. M. No. 36979); Coxsackie 8 (U. S. N. M. No. 3787); Fallsburg 4 (M. C. Z. No. 1176); Highland Falls 2 (U. S. N. M. No. 23211-2); Berkshire 4 (M. C. Z. No. 176, 239, 288); Ithaca 16 (M. C. Z. No. 3156-7, 3159-62, 3164-8, 4659-60, U. S. N. M. No. 39411, 39414); Allegany Co. 2 (U. S. N. M. No. 3768); Niagara Falls 6 (U. S. N. M. No. 57024-7, 57097-8); Somerville 40 (M. C. Z. No. 164-5; 187, 191, 1188); no locality 1 (U. S. N. M. No. 4891).

New Jersey: Bergen Co. 3 (Field No. 1975); Hackensack 5 (Field No. 1974); Plainfield 2 (M. C. Z. No. 2304); Culver's Lake 1 (Carnegie No. 3079); Cedar Lake, Warren Co. 1 (A. N. S.); Swartswood Lake 1 (A. N. S.); Sussex Co. 1 (A. N. S.); Schooley's Mt. 3 (M. C. Z. No. 162); Bordentown 1 (A. N. S.); Dias Cr. 1 (A. N. S.); Higbee's Beach 1 (A. N. S.); Cape May 11 (A. N. S., M. C. Z. No. 5139-48).

Pennsylvania: Dingman's Ferry 1 (A. N. S.); Ganoga Lake 1 (A. N. S.); Bartonville 1 (A. N. S.); Sylor's Lake 1 (A. N. S.); Monocacy 1 (A. N. S.); Woodbourne 1 (A. N. S.); Langhorne 1 (A. N. S.); Norristown 3 (M. C. Z. No. 1413-4); Valley Forge 2 (E. R. D., A. N. S.); Devon 1 (A. N. S.); Centerville 1 (A. N. S.); Gladwyne 1 (A. N. S.); Wissahickon 1 (A. N. S.); Fairmount Park 2 (A. N. S., E. R. D.); Philadelphia 1 (A. N. S.); Frank-

ford 1 (A. N. S.); Holmesburg 1 (A. N. S.); Rowlands 1 (A. N. S.); La Grange 1 (A. N. S.); Germantown 1 (A. N. S.); Haverford 36 (E. R. D.); Cobb's Cr. 1 (A. N. S.); Chester Heights 1 (A. N. S.); Langford's Run 1 (A. N. S.); Wawa 1 (A. N. S.); Chadd's Ford 1 (A. N. S.); Londongrove 3 (M. C. Z. No. 1413-4); York Furnace 1 (A. N. S.); Carlisle 20 (U. S. N. M. No. 3790, 3835); Mount Joy 1 (U. S. N. M. No. 4885); Bainbridge 1 (U. S. N. M. No. 8573); Port Alleghany 1 (A. N. S.); Gold 1; Indiana 1 (A. N. S.); Besnham Run 1 (A. N. S.); Two Lick Cr. 1 (A. N. S.); Meadville 31 (U. S. N. M. No. 3759, 3764); Boston 2 (Carnegie No. 1274-5); Carnegie 1 (Carnegie No. 1224); McKeesport 1 (Carnegie No. 976).

Delaware: Brandywine Cr. 1 (A. N. S.); Greenville 1 (A. N. S.); Seaford 1 (A. N. S.); Newark 1 (A. N. S.).

Maryland: Cecil Co.: Bohemia Manor 1 (A. N. S.); Chestertown 1 (A. N. S.); The Rocks 1 (A. N. S.); Willards 1 (A. N. S.); Laurel 6 (U. S. N. M. No. 42919-20, 45575-8); Woodside 24 (25266-7, 25273-87, 49765-71); Cabin John 5 (U. S. N. M. No. 55474-8); Great Falls 1 (U. S. N. M. No. 17347).

District of Columbia: Takoma Park 7 (U. S. N. M. No. 17116-9, 17121-2, 19052); Rock Creek Park 15 (U. S. N. M. No. 15516, 22772, 50652-7, 51163-4); Ridge Road 2 (U. S. N. M. No. 33872-3); Brookland 1 (U. S. N. M. No. 16674); Cleveland Park 3 (U. S. N. M. No. 46189-91); no locality 75 (U. S. N. M. No. 4898, 7823, 13314, 17345-6, 23924-5, 33874, 39254, 50633-51).

Virginia: Alexandria 2 (E. R. D.); Fort Myer 1 (U. S. N. M. No. 22414); Pohick 2 (E. R. D., U. S. N. M. No. 54761); Great Falls 9 (U. S. N. M. No. 23931, 40066, 50042, 50672-4, 53616-8, Blanchard); Falls Church 34 (U. S. N. M. No. 24334-6, 26103-31, 36106-7); Munson's Hill 4 (U. S. N. M. No. 17661, 17685-7); Bailey's Cross Roads 2 (M. C. Z. No. 4763-4); Fairfax Co. 1 (U. S. N. M. No. 13316); Loudoun Co. 1 (U. S. N. M. No. 66486); Aldie 1 (E. R. D.); Delaplane 3 (U. S. N. M. No. 39028-30); Clarke Co. 27 (U. S. N. M. No. 3766, 3818); Stony Man Mt. 22 (U. S. N. M. No. 29267-88); Strasburg 4 (M. C. Z. No. 2031); Hampton 3 (U. S. N. M. No. 31654-5); Norfolk 1 (M. C. Z. No. 4725); Midway Mills 4 (E. R. D.); Bedford Co. 1 (U. S. N. M. No. 36713); Endless Caverns 1 (S. C.); Crozet 1 (M. C. Z. No. 5223); White Top Mt. 9 (M. C. Z. No. 7109-16).

North Carolina: Beaver Cr., Ashe Co. 32 (Breder); Linville 65 (M. C. Z. No. 6246-61, A. M. N. H. No. 4536-44, 4677, 4715-20, 5011-41, 5054); Waynesville 4 (S. C., Chapin); French Broad R. 1 (A. N. S.); Pisgah Forest Reserve 1 (U. Mich.).

Georgia: Dallas 2 (M. C. Z. No. 1834); no locality 6 (U. S. N. M. No. 4720, M. C. Z. No. 154, 241).

Mississippi: No locality 1 (U. S. N. M. No. 37636).

Ohio: Trumbull Co. 3 (U. S. N. M. No. 57023, 57104-5); Sandusky 3 (U. S. N. M. No. 35678-80); Columbus 1 (U. S. N. M. No. 3805); Lancaster 1 (U. S. N. M. No. 3765); Hamilton Co. 2 (U. S. N. M. No. 57102-3); Cincinnati 1 (U. S. N. M. No. 57101); Ripley 1 (U. S. N. M. No. 3783).

Indiana: Brookville 1 (U. S. N. M. No. 4839); Richmond 1 (U. S. N. M. No. 17503);

Lafayette 27 (U. S. N. M. No. 17975-801); Lake Maxinkuckee 14 (U. S. N. M. No. 42598, 42605-17); Millers 2 (Field No. 2844); Mineral Springs 5 (Field No. 2764, 2805); Vigo Co. 7 (M. C. Z. No. 7210-6); Putnam Co. 1 (M. C. Z. No. 7217); Mecca 2 (M. C. Z. No. 7283-4); Ft. Ritner 1 (M. C. Z. No. 7285); Posey Co. 6 (M. C. Z. No. 7287-91).

Illinois: No locality 6 (U. S. N. M. No. 5415, M. C. Z. No. 1828).

Michigan: Flint 2 (M. C. Z. No. 2113); Marquette Co. 2 (M. C. Z. No. 2110); Wakefield 12 (U. S. N. M. No. 51943-54); Detroit 15 (U. S. N. M. No. 3770 TYPES *Salamandra agilis*).

Wisconsin: Madison 1 (U. S. N. M. No. 10903); Racine 8 (U. S. N. M. No. 3788); Owl Lake, Iron Co. 2 (U. S. N. M. No. 33142-3).

Tennessee: Franklin Co. 1 (U. S. N. M. No. 57106); Rock Creek 1 (A. N. S.); Roan Mt. 7 (A. N. S.).

Missouri: St. Louis Co. 4 (U. S. N. M. No. 35728-9, 57090-1); Jefferson Co. 1 (U. S. N. M. No. 57095); Silica 2 (U. S. N. M. No. 57093-4); St. Francois Co. 1 (U. S. N. M. No. 57092); Stone Co. 2 (U. S. N. M. No. 57088-9); Marble Cave 1 (U. S. N. M. No. 48859); Chadwick 1 (A. N. S.); no locality 1 (U. S. N. M. No. 57087).

Arkansas: Roger 1 (A. N. S.); Magazine Mt. 1 (A. N. S.).

It has also been recorded from the following additional localities:

Canada: Prince Edward I. (Cox 1899); Breton I., Gaspé, Islands in Bay of Fundy (Verrill 1862); Otter Lake, Ont. (Wright and Simpson 1921); Bruce City (Müller 1889); Collingwood (Kennicott 1883); Fort William (Cope 1889).

Maine: Norway (Verrill 1862).

New Hampshire: Intervale (Allen 1899); Waterville (Evermann 1918); Snowville (Murphy 1917); Hanover (Worthen 1891).

Vermont: Burlington (Thompson 1842).

Massachusetts: New Bedford (Allen 1870); Amherst (Storer 1839); Fitchburg (Putnam 1865); Worcester, Auburn, Holden (Cochran 1911).

Rhode Island: Rumford (Murphy 1918); Lincoln (Drowne 1905).

New York: Saranac (DeKay 1842); Albany Co. (Bishop 1923); Poughkeepsie (Smith 1882); Staten I. (Davis 1884); Wayne Co., Monroe Co. (Wright and Moesel 1919); Buffalo, Bessemer (Reed 1908); Chautauqua (Reed and Wright 1908).

New Jersey: Alpine, Mantua, Ridgewood, Kinkora, Trenton (Fowler 1907); High Bridge, Hunterdon Co. (Fowler 1908); Beverly (Street 1914); New Brunswick (Crozier 1925).

Pennsylvania: Carbon Co., Weissport; Luzerne Co., Wilkes-Barre; Wyoming Co., Meshoppen; Bradford Co., Rummerfield; Wayne Co., Honesdale (Surface 1913); Sullivan Co., Hillsgrove (Bishop 1925); Lehigh Co., Allentown, Slatedale, Laury's, Mountaindale (Mattern and Mattern 1917); Berks Co., Fleetwood, Kutztown, Allentown, Joanna; Montour Co., Danville; Northampton Co., Easton, Bethlehem, Portland; Lebanon Co., Annville, Myerstown; Dauphin Co., Dauphin, Harrisburg, Rockville, Weissport; Bucks Co., Forest Grove, Doylestown, Benjamin; Chester Co., Coatesville, Paoli; Delaware Co., Wayne; Lancaster Co., Mt. Joy, Elizabethtown, Willow Street;

Montgomery Co., Perkasie, Bryn Mawr, Morristown, Ringing Rock, Pottstown; Lycoming Co., Williamsport (Surface 1913), Loyalsock; Tioga Co., Blossburg, Liberty (Bishop 1925), Mainesburg (Surface 1913); Center Co., State College (Bishop 1925); Huntingdon Co., Huntingdon; Perry Co., Marshrun, Blain; Cumberland Co., Enola, Camp Hill, New Cumberland; York Co., York, Pigeon Hills; Franklin Co., Mont Alto; Adams Co., Zora, Gettysburg (Surface 1913); Arendtsville (Bishop 1925); Fulton Co., McConnellsburg; Erie Co., Waterford; Clarion Co., Clarion; Warren Co., Grand Valley, Corydon; Butler Co., Chicora; Beaver Co., New Brighton; Allegheny Co., Swissvale, Wilkinsburg (Surface 1913).

Delaware: Wilmington (Fowler 1925).

Maryland: Cecil Co., Bacon Hill, Northeast (Fowler 1915); Deer Creek, South River (Fowler 1925).

North Carolina: Mitchell Co., Pitt Co. (Brimley 1907); Andrews (Brimley 1912); Sunburst, Greenville (Brimley 1915); Raleigh (Brimley 1922).

South Carolina: Camden (DeKay 1842).

Ohio: Worthington, Sugar Grove (Morse 1901); Lorain Co., Youngstown, Newton Falls (Morse 1904).

Indiana: New Harmony, North Manchester, Crawfordsville, Monroe Co. (Hay 1893); Vincennes (Gaines 1895); Perry Co. (Ortenburger 1920); Terre Haute (Blatchley 1891).

Michigan: Ontonagon Co. (Ruthven 1904); Baraga Co. (Ruthven 1906); Schoolcraft Co. (Gaige 1915); Whitefish Point, Chippewa Co. (Thompson and Thompson 1912); Dickinson Co. (Thompson and Thompson 1912); Cheboygan Co. (Ruthven 1911); Antrim Co., Montcalm (Clark 1905); Huron Co. (Ruthven 1911); Benzie Co., Manistee Co., Gratiot Co., Ingham Co., Lenawee Co., (Thompson and Thompson 1912); Eaton Co. (Clark 1904); Washtenaw Co. (Smith 1882); Barry Co., Wall Lake (Potter 1920).

Missouri: Madison Co. (Hurter 1911).

Ensatina platensis (Espada).

from An. Soc. española Hist. Nat., IV, Pl. I

Fig. 1.—Side of head, showing postocular grooves.
Fig. 2.—Front of head, showing nasolabial grooves.
Fig. 3.—Inside of mouth, showing nares, vomerine, and parasphenoid teeth.
Fig. 4.—Tongue from side, attached in front.
Fig. 5.—Under side of hand showing palmar tubercles.
Fig. 6.—Cross section of tail.

The figure of the animal shows the basal constriction of the tail.

ENSATINA GRAY

1850 *Ensatina* Gray, Cat. Batr. Grad. Brit. Mus., p. 76 (type *eschscholtzii*).
1856 *Heredia* Girard, Proc. Acad. Nat. Sci. Philadelphia, p. 140 (type *oregonensis*).
1870 *Urotropis* Espada, An. Soc. Español. Hist. Nat. 4, p. 70 (type *platensis*) (not *Urotropis* Rafinesque 1822, Kentucky Gazette, N. S. 1, 9, p. 3).

Diagnosis: Tongue attached in front; two premaxillae, nasal spines not fused, a fontanelle; septomaxilla present; maxilla normal; prefrontals present, bordering nares; internal nares a notch in prevomer; vomerine and parasphenoid series not continuous; condyles sessile; atlas normal; eyes functional; no aquatic larval stage; no marked sexual dimorphism; tail with basal constriction; toes 4-5, free; terminal phalanges T-shaped; two tubercles on palm; 3 species.

Range: British Columbia to Lower California; Uruguay and Argentina.

Key to species of *Ensatina:*

A. No dorsal markings, Washington to Lower California, in Coast ranges and in Cascades . . . . . *eschscholtzii* 188
AA. Paired dorsal light spots.
B. 12 costal grooves, Sierra Nevadas, California . . *croceater* 185
B B. 10-11 costal grooves, Uruguay and Argentina . *platensis* 181

ENSATINA PLATENSIS (JIMENEZ DE LA ESPADA)

1875 *Urotropis platensis* Jimenez de la Espada, An. Soc. Españ. Hist. Nat. 4, p. 71, pl. 1.
1882 *Plethodon platensis* Boulenger, Cat. Bat. Grad. Brit. Mus. (2), p. 55; Berg 1896, An. Mus. Buenos Aires 5, p. 147.
1923 *Ensatina platensis* Dunn, Proc. New England Zoöl. Club 7, p. 39.

Type: In Madrid Museum(?).

Type locality: Montevideo(?), Uruguay.

Range: Known only from type locality, and from vicinity of Buenos Aires.

Diagnosis: An *Ensatina* with dorsal light markings; 10-11 costal grooves; otherwise similar to *E. croceater.*

Description: As I have seen no specimens of this species I quote the following from Jimenez de la Espada (1875): "Trunk and tail robust; extremities somewhat slim. Head depressed, with the crown flat and

horizontal from the neck anteriorly to beyond the eyes; with the rostrum broad and flat between the orbits and the nostrils, convex beyond them; snout broad, blunt, and projecting beyond the lip. The openings of the nostrils, which mark the lateral extremities of the snout, are situated in two projecting points, are circular, and are open forwards and upwards; from the middle of their lower borders depart sinuous and somewhat converging grooves, which fork before reaching the edge of the lip. The eyes are big and protruding. The outline of the mouth is semi-circular. The sphenoidal teeth, sharp and hooked, are arranged like the teeth of a teasel in two wide and oblong plates, touching at their anterior ends, curved outwards, with the outer edge concave, the inner convex, and the posterior round; between them an angular space. The palates are robust and form two arcs of a circle, which start from the center of the roof of the mouth, and at a great distance from the sphenoids, follow exactly the antero-internal border of the orbits, and terminate very close to the edge of the lip. The teeth, which are like those on the mandible and the maxilla, are spaced along these arcs. The choanae are in front of these and in contact with them. They are small, transversely oval, and their enfoldings as well as their edges are prolonged into a marked sulcus or canal, along the palatine arc, opening between its outer point and the maxilla. The tongue, when retracted, has its posterior third in the throat; the stalk of it is very thick, and a very thin and transparent veil or membrane stretches between the stalk and the strip which attaches the tongue anteriorly to the mandibular symphysis; the structure of this organ is similar to that characteristic of the genus *Chioglossa* of our Peninsula, and of *Plethodon* and of *Desmognathus* of North America.

"The cervical region maintains in its anterior two-thirds the same width as the cephalic, but narrows notably in the posterior third. The trunk, thickened in the middle, narrows gradually to the shoulders and the hips. The genito-caudal region, taken from the posterior side of the thighs to the furthest extremity of the cloacal slit, is a truncated cone, somewhat compressed laterally and flat above. The base of the tail, properly speaking, is marked by two lateral compressions and a complete annular sulcus, beyond which the tail swells, then, having passed the proximal fifth, diminishes without interruption and insensibly to the tip (tail pointed, rounded above, keeled below).

"The arms and forearms are smooth; the hand depressed, as are the fingers, whose tips are blunt and swollen beneath and somewhat coriaceous; webbing is lacking; the third exceeds the rest in length, the second is next, then the fourth, and the first or inner is shortest of all; the wrist carries on its outer edge an oval and slightly compressed spur, raised by the last of the carpal bones; there is another smaller conical one on the palm, at the base of the inner finger; under the ends of the metacarpals are swellings like infra-articular tubercles.

"The posterior extremities are also smooth and more robust in proportion to the thoracic; the digits are similar to those of the hand and like them are entirely free; on the sole there are no protuberances save the metatarsal tubercles.

"In the skin, whose general surface is smooth, there are some granular pockmarks scattered over the parotic regions, and others larger and confusedly grouped over the upper half of the tail. Besides these there are: a groove along the spine; two short, perpendicular furrows behind and somewhat distant from the angles of the mouth; a fold in the fashion of a collar or choker, further from the angles of the mouth than from the shoulders, which fold, converted into a groove or furrow, crosses the sides of the neck describing an arc and meeting the upper end of the groove behind the mouth; another less marked groove, which forms an angle of little less than 45 degrees with the ascending arc; and finally, on each side, ten or eleven annular grooves.

"The parotic glands have no apparent openings; they begin behind and below the eyes, and end above the shoulders; they are divided into three portions; horizontally, by the lateral grooves of the throat fold; vertically, by the furrow behind the mouth.

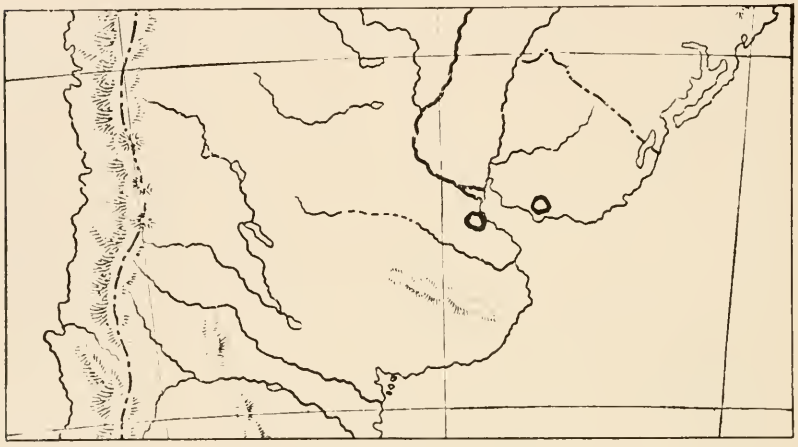
"The whole superior surface is in general tobacco color, somewhat darker on head and tail, passing into a dirty flesh color on the inferior surface. On this background are: two irregular dorso-longitudinal series of yellow, irregular spots whose outline is indented; these unite on the tail, forming more or less close and disorderly groups; others in the middle of the back of the neck; two series of larger ones along the parotic glands, on the sides of the neck, running onto the upper eyelids; and finally a little group of two or three on the mid point of the snout. The yellow color of these spots is paler in those which are on the arms, forearms, thighs, and posterior side of the

shins, and these run together so much at times that they almost hide the general dark color of the skin."

Total length 125 mm., head 18, body 55, tail 52.

Remarks: This animal is extremely close to *E. croceater*. As I have seen no specimens I cannot give any comparisons. No good distinguishing characters appear in the description quoted above, nor in the plate, which is the best figure of an animal of this family so far made.

Ten or eleven costal grooves perhaps may be contrasted with the twelve present in *croceater*.



21. Part of Uruguay and Argentina, showing localities for Ensatina platensis.

Jimenez de la Espada says: "I regret extremely that it is not possible for me to determine exactly the locality where it was caught. I received it from my traveling companion Sr. Martinez y Saez, along with various reptiles from the neighborhood of Montevideo or from its Province, and noticed it in Chile when we were arranging and annotating our third shipment to Spain. I remember very well that I remarked upon the find to the Director of the Museum of Santiago, my good friend Dr. Rodulfo Armando Philippi, who took it for an interesting novelty. When I wished to verify this opinion, long afterwards, my companion was doubtful as to the person from whom he

received the urodele, whether it was Sr. D. Fernando Amor, or the Ex. Sr. D. Patricio Maria Paz y Membiela; and these gentlemen died, one during the trip, the other more than a year ago. But my carelessness has no other consequence than the lack of local data in the account of the new batrachian, a lack always noticeable, but it does not detract from the importance of the discovery, which consists in the region that it inhabits, not in the district, place, or spot where it lived."

The only additional information on this animal is the mention by Berg (1896) of "the capture of two specimens by Dr. Carlos Speggezini in February, 1887, in a ditch near the Ensenada, Province of Buenos Aires," Argentina.

ENSATINA CROCEATER (COPE)

1867 *Plethodon croceater* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 210; 1869, Proc. Acad. Nat. Sci. Philadelphia, p. 100; Boulenger 1882, Cat. Bat. Grad. Brit. Mus. (2), p. 55; Cope 1889, Bull. U. S. Nat. Mus. 34, p. 150; Van Denburgh 1916, Proc. California Acad. Sci. (4), 4, 7, p. 220; Grinnell and Camp 1917, Univ. California Publ. Zoöl. 17, 10, p. 132, f. 2; Stejneger and Barbour 1917, Check List, p. 14.

1923 *Ensatina croceater* Dunn, Proc. New England Zoöl. Club 7, p. 39; Stejneger and Barbour 1923, Check List (2), p. 12; Dunn 1924, Copeia 133, p. 76; Storer 1925, U. California Publ. Zoöl. 27, p. 104.

Type: U. S. Nat. Mus. No. 4701. Now lost, according to Stejneger (see Van Denburgh 1916). In the collection of the Department of Zoölogy, University of California, according to Grinnell and Camp (1917). Collected by John Xantus.

Type locality: Fort Tejon, California(?).

Range: From Alta, Placer Co., California to Fort Tejon, Kern Co., California, in the Sierra Nevada. Baja California(?).

Diagnosis: An *Ensatina* with dorsal light markings; 12 costal grooves.

Description: Mus. Vert. Zoöl., U. California, No. 7372, adult male; North Fork, Madera Co., California, 3,000 feet alt.; 12 costal grooves; appressed toes overlapping; head width 5 in length from snout to vent; head length 2⅔ in length of body; head an oval as seen from above; eye longer than its distance from tip of snout; snout slightly swollen; outline of upper jaw convex as seen from side; angle of jaw back of hind angle of eye; lower eyelid fitting under upper in front and

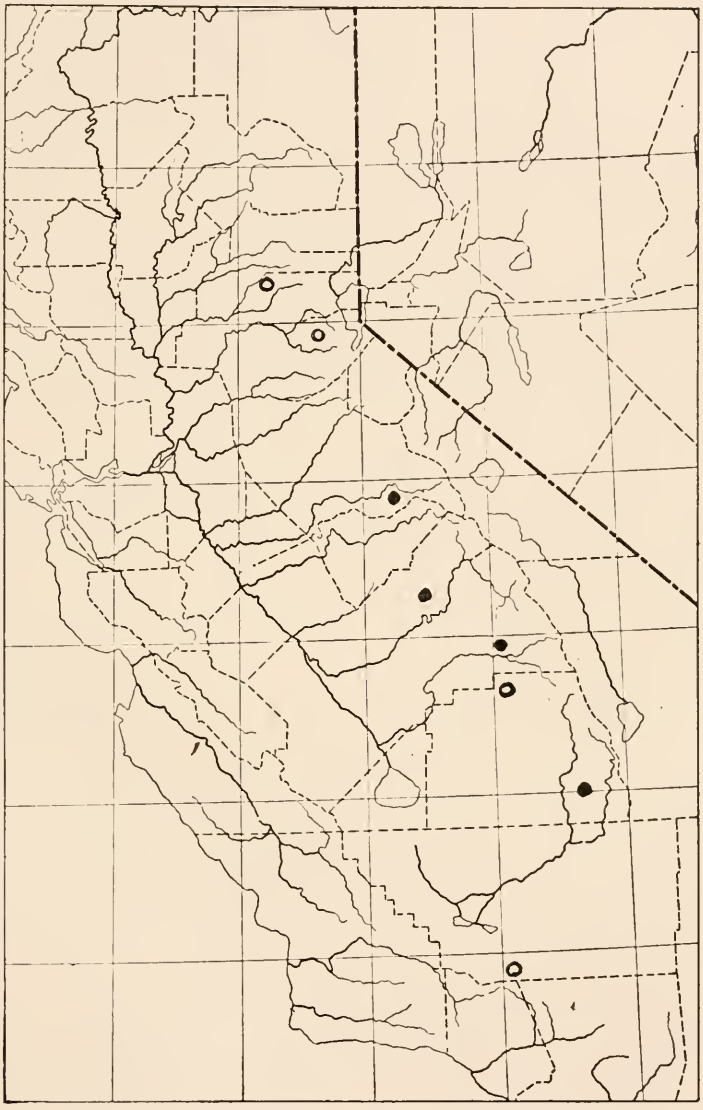
behind; a groove from hind angle of eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; two palmar tubercles and a tubercle at base of second, third, and fourth fingers; toes 4, 3, 2, 5, 1 in order of length; tubercle at base of second, third, and fourth; tail constricted at base; shorter than head and body, trigonal in cross section, upper surface rounded, a ventral keel; anal lips lined with papillae; vomerine series not continuous with parasphenoid; about 17 teeth in series beginning beyond outer edge of naris, curving in and back, separated from its fellow by twice width of naris and from parasphenoids by twice that distance; latter in two patches, beginning opposite last third of eye-socket; black above, lighter below; upper arms and thighs light; a series of irregular light spots on each side of back, and light spots on tail; total length 118 mm., head 17, body 45, tail 56.

Variation: A female, Mus. Vert. Zoöl., U. California, No. 7368, from South Fork, Madera Co., California, has appressed toes just meeting; head width 5½ in length from snout to vent; head length 3 in length of body; tail shorter than body; no anal papillae; vomerine series of 24 teeth, separated from fellow by width of naris; color much lighter than that of described male; black above, orange below; upper arms and thighs orange; orange spots on fore arms and lower legs; a row of irregular orange spots on each side of dorsal region, beginning on eyelids; irregular orange spots on upper surface of tail; total length 131 mm., head 19, body 57, tail 55.

A young specimen, Mus. Vert. Zoöl., U. California, No. 7367, from North Fork, has head width 4¼ in length from snout to vent; head length 2½ in length of body; tail shorter than body; black above and below; thighs and forearms orange; a double row of tiny light spots on each side; upper row orange and corresponding to the spots of the adults; lower row along edge of belly, white; total length 39 mm., head 7.5, body 19, tail 12.5.

Remarks: I am strongly of the opinion that this form is confined to the Sierra Nevada. Cope (1889) mentions having seen a specimen from Cape San Lucas, and Lockington records it from "75 miles southeast of San Diego." Against this should be placed the occurrence of *eschscholtzii* in the San Bernardino Mts. (Grinnell and Camp 1917), which lie between the Sierras and Baja California. Probably Lockington's specimen came from the San Pedro Martir Mts.

and was *eschscholtzii*. Van Denburgh (1916) happily suggests that Cape San Lucas in Cope "may have resulted from the association of



22. California, showing localities for Ensatina croceater.

the original specimen with John Xantus, who collected both at Cape San Lucas and Fort Tejon."

The question of the type is quite puzzling. It was No. 4701 in the National Museum. It is not there now. Grinnell and Camp (1917) say "what is probably the type is contained in the collection of the Department of Zoölogy, University of California." It is hard to believe this latter statement. U. S. N. M. 4701 is stated in the catalog of that institution to have been collected at Fort Tejon by John Xantus. Some doubt is cast on this by the fact that the type of *Plethodon intermedius* (U. S. N. M. 4732), which has the same data almost certainly never came from California.

To the North *croceater* apparently gives place to *eschscholtzii* before Mt. Shasta is reached as I have seen the latter from there.

The relationship between the three species of *Ensatina* is very close. The striking resemblance between *platensis* and *croceater* is more remarkable when one considers that the Sierra species is closer to the one from Argentina than to the Coast Range form.

Van Denburgh (1916) has suggested that *Plethodon flavipunctatus* Strauch refers to *croceater*. A careful reading of Strauch's description leads me to believe that he had an *Aneides*. The vomerine teeth of *flavipunctatus* are not described as resembling those of any *Ensatina*.

Besides the localities mentioned below it has been recorded from the following: Fort Tejon, Kern Co., Cal. (Cope 1867); Grant [Giant] Forest, Sequoia National Park, Tulare Co., Cal. (Grinnell and Camp 1917); Eldorado Co. (Stejneger and Barbour 1917); and Alta, 3,600 feet altitude, Placer Co., Cal. (Grinnell and Camp 1917).

Specimens seen 12, as follows:

California: Dalton R., Fresno Co., 5,000 ft. 1 (Mus. Vert. Zoöl. 7395); Mud Spring, 6,300 ft., 4 miles southwest of Nelson, Tulare Co. 3 (Mus. Vert. Zoöl. 5618-5620); Madera Co., Malum Ridge, North Fork 1 (Mus. Vert. Zoöl. 7369); North Fork, 3,000 ft. 4 (Mus. Vert. Zoöl. 7367, 7370, 7372, 7374); South Fork 2 (Mus. Vert. Zoöl. 7368, 7371); Yosemite Valley, Tuolumne Co. 1 (Mus. Comp. Zoöl. 8167).

ENSATINA ESCHSCHOLTZII GRAY

1850 *Ensatina eschscholtzii* Gray, Cat. Batr. Grad. Brit. Mus., p. 48; Dunn 1923, Proc. New England Zoöl. Club 7, p. 39; Stejneger and Barbour 1923, Check List (2), p. 12; Storer 1925, U. California Publ. Zoöl. 27, p. 104, pl. 9, f. 22, 23.

1917 *Plethodon eschscholtzii* Grinnell and Camp 1917, Univ. California Publ. Zoöl. 17, 10, p. 132, f. 2; Stejneger and Barbour, Check List, p. 15; Dunn 1918, Bull. Mus. Comp. Zoöl. 52, p. 459; Noble 1925, Journ. Morph. 40, p. 373, f. 19, 30, 31a (skin).

1856 *Heredia oregonensis* Girard, Proc. Acad. Nat. Sci. Philadelphia, p. 235; 1858, U. S. Expl. Exped., Herp., p. 11, pl. 1, ff. 18-25.

1869 *Plethodon oregonensis* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 100; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 54; Cope 1883, Proc Acad. Nat. Sci. Philadelphia, p. 28; Yarrow 1883, Bull. U. S. Nat. Mus. 24, pp. 21, 155; Cope 1889, Bull. U. S. Nat. Mus. 34, p. 148, f. 35, pl. 35, f. 1; Van Denburgh 1898, Proc. Amer. Phil. Soc. 37, p. 140 (breeding habits); Hubbard 1903, Univ. California Publ. Zoöl. 1, 4, p. 157, pl. 16 (caudal glands; Esterly 1904, Univ. California Publ. Zoöl. 1, 7, p. 228, pl. 20-23 (caudal glands); Rüthling 1915, Copeia 25, p. 62; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 26; Emmel 1924, Amer. Journ. Anat. 33, p. 351, pl. 1, ff. 13-15, pl. 7, ff. 82-4 (erythrocytes).

1867 *Plethodon ensatus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 167 (not *Triton ensatus* Eschscholtz, 1833, Zoöl. Atlas, pt. 5, p. 6, pl. 22).

1880? *Plethodon croceater* Lockington, Amer. Nat., p. 296; Schmidt 1922, Bull. Amer. Mus. Nat. Hist. 46, p. 632.

Type: In British Museum.

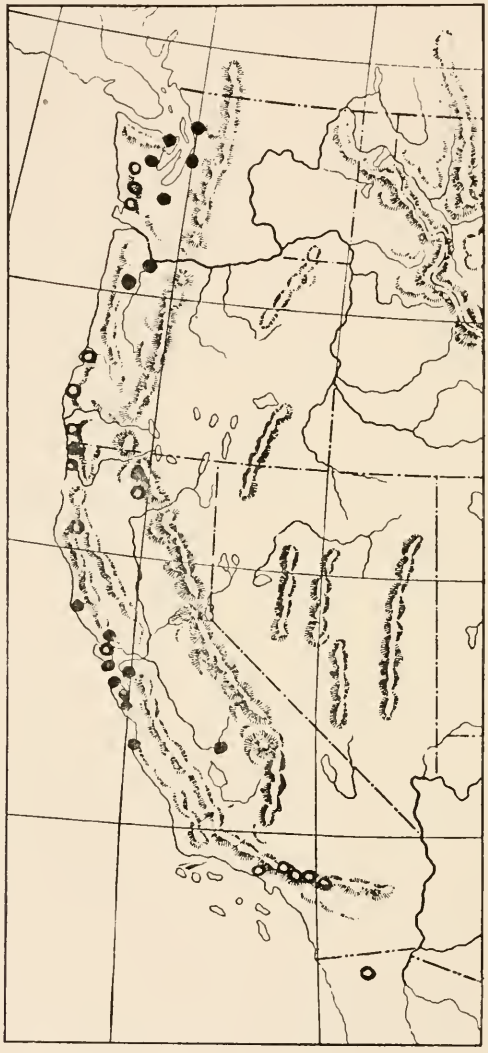
Type locality: Monterey, California.

Range: Washington to Baja California; Coast Ranges, Cascades, Olympics, San Bernardinos, San Pedro Martirs. One specimen from Fresno in the Sacramento Valley.

Diagnosis: An *Ensatina* without dorsal light markings; 12-13 costal grooves.

Description: U. S. N. M. No. 49893, adult male, Sausalito, Cal.; 12 costal grooves; appressed toes meeting; head width 5½ in length from snout to vent; head length 2¾ in length of body; head oval; eye as long as its distance from tip of snout; snout swollen, especially in region of nostrils; outline of upper jaw concave as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length, a tubercle at base of 4; toes 4, 3, 2, 5, 1 in order of length; tail longer than head and body, terete, a constriction at base; vent lined with papillae; vomerine teeth 18 in series, beginning beyond outer edge of nares, curving in and back, separated from its fellow by width of nares and from the parasphenoids by thrice that distance; latter in a single patch forking posteriorly, beginning opposite the posterior fourth of the eyesocket; brownish purple above, cream color

below a line joining the insertions of the legs; cream color on snout; upper arms and thighs light; tail bicolor; costal grooves invaded somewhat by belly color; total length 123, head 16, body 44, tail 63.



23. Pacific Coast, showing localities for Ensatina eschscholtzii.

Variation: A female, U. S. N. M. No. 51060, same data, differs in having head width 5⅓ in length from snout to vent; snout not swollen; walls of vent smooth; 13 costal grooves; outline of upper jaw straight; total length 63, head 17, body 46, tail 0.

U. S. N. M. No. 53604, adult male, Sausalito, Cal., has the tail shorter than the body, and the vomerine series are separated from the parasphenoids by 4 times the width of the nares.

U. S. N. M. No. 404, adult female, Petaluma, Cal., has 28 teeth in the vomerine series, which is separated from its fellow by ½ width of nares, and from the parasphenoids by twice width of nares.

U. S. N. M. No. 53419, young, from Oregon, has a dark belly.

U. Mich. No. 58899, young, from Crescent City, Cal., has a light dorsal band, the sides being dark and the belly light.

The largest and smallest specimens seen are as follows:

♀ A. M. N. H. No. 15623 Carmel, Cal.	Total 115,	head 20,	body 58,	tail 37
♀ U. S. N. M. No. 4004 Petaluma, Cal.	" 132	" 20	" 57	" 55
♂ U. S. N. M. No. 4004 Petaluma, Cal.	" 128	" 19	" 45	" 64
yg. U. S. N. M. No. 4004 Petaluma, Cal.	" 32	" 6.5	" 14.5	" 11

Habits: This animal apparently lives on the ground and under logs in the redwood forests of the Coast Range. Van Denburgh (1898) records the finding of a female with eggs on April 19, at Mill Valley, Marin Co., Cal. He says: "The salamander and eggs had been found together under a decaying log in the redwood woods. . . . The eggs . . . are very large (6 mm. in diameter) and almost or quite without pigment. They were covered with a thin gelatinous coating which caused them to stick together. . . . The salamander took charge of the eggs, lying beside them and holding them in a loop of its tail. Evidently dissatisfied with their position and surroundings, the *Plethodon* moved the eggs from place to place in the jar, holding them always in the crook of its tail. This was done several times in the course of 3 or 4 days and the solicitude of the salamander continued until the eggs were quite moldy."

Hubbard (1903) gives an account of a quite different use of the tail. This organ is provided with large poison glands, and also with a groove at the base for autotomy. She describes experiments with a ring-neck snake *(Diadophis)* which "three times . . . seized the *Plethodon* round the middle and worked toward the caudal end of the body. Then each time, but not until then, the salamander poured out the milky secretion on its tail and the snake released its hold.

Upon the fourth attack of this kind the *Plethodon* dropped its tail and wriggled away, only to lose the battle, for then the *Diadophis* devoured it tail and all, not, however, without some gagging afterwards." Another time a different salamander on being approached by a snake, "the *Plethodon,* which had been perfectly motionless for some time, suddenly, without moving the rest of the body, raised its tail and with a *sidewise motion* struck the *Diadophis* squarely in the face. Somewhat daunted by this reception the enemy retreated, but in a moment or two came up again, this time from behind. When the snake's mouth was very near, the salamander, rigid in every other part of its body, suddenly raised its tail, as a cat arches its back at a worrying dog. At the same time the tail became covered with the milky fluid. *Diadophis,* making a brief survey, retreated again, and the *Plethodon,* after remaining motionless in this position for several minutes, . . . gradually lowered its tail until it rested on the floor. The snake did not approach the salamander again."

Storer (1925) gives further details of the habits: "All of the specimens at hand were collected under objects resting on the surface of the ground or in the burrows of earth-dwelling rodents only a few inches below the ground surface. In common with other Plethodonts in central California *eschscholtzii* usually disappears from its surface haunts at the approach of the dry season and reappears soon after the first autumn rains. The nature of its aestival retreat is unknown save in a few instances where individuals have been found in rodent burrows.

"Camp (MS.) says that in Bailey Cañon near Sierra Madre, one was found at an altitude of about 1,200 feet, in a tunnel entrance in the cañon bottom. Six others, seen at various times in the golden oak belt of the same cañon at about 2,300 feet altitude, were found in the following sorts of surroundings: (1) beneath a box in rather dry soil, (2) in a cellar beneath a cabin, (3) among wet leaves, (4) several inches below the ground surface in loose wet earth, (5) in a rather large hollow log.

"The fortunes of a group of four adults and two young individuals which lived beneath boxes and boards in a grove of Pittosporum trees on the Berkeley campus were followed for a time in the winter of 1921-22. During the spring of 1921 all of the salamanders of this species, with possibly one exception, had been removed. None was

seen during the dry summer period, but with the first autumn rains several individuals of *eschscholtzii* appeared. Repeated daytime examinations during November and December showed that the animals made frequent changes of location. On one day they would be under a large box beside a building; on another occasion they would be found out under boards, 20 feet away but still in the leaf mat under the trees. The young moved about in the same way as the adults. Evidently any convenient shelter served as harbor for the animals during the day, their restriction to the general neighborhood being brought about by the zone of harder and drier ground outside the grove and also by the lack of shelter in that direction.

"The box which furnished the principal shelter for the salamanders was removed on January 24, 1922, up to which time the animals had been present continuously; thereafter they could not be found. Another box placed in the same situation a day or two later failed to attract any salamanders. This suggests that the original population comprised the only individuals of *eschscholtzii* present in the grove, and that when their principal daytime shelter was removed the animals made a permanent change of base, after which they did not return to their former haunt.

"Captive specimens when handled sometimes stand up high on their toes. When handled roughly by grasping the head or body the tail is apt to be swept around laterally — alligator fashion — and at the same time the glands on the tail begin to secrete a colorless fluid. This species displays some agility in movement; when dropped from the hand an individual usually manages to turn during the course of the descent so as to alight on the feet, or at least on the ventral surface.

"During excavation of a tunnel system of the rodent, *Aplodontia rufa phaea,* in the hills three miles west of Inverness, Marin County, on June 4, 1913, two individuals of *Ensatina eschscholtzii* were found in one of the underground compartments. With the salamanders there was a group of 13 'white' eggs. According to the field notes (C. L. Camp, notebook in Mus. Vert. Zoöl.) the larger of the two salamanders 'seemed very much bloated and almost transparent when taken. As I held it in my hand it emitted about ¼ ounce of clear odorless liquid and became normal in size.' These eggs after preservation in alcohol measure 5.5 to 5.75 millimeters in diameter and the outer jelly coat 5.9 to 7.5 millimeters.

"At Carlotta, Humboldt County, on July 26, 1923, Dr. Joseph Grinnell found two adult individuals, each in attendance upon a cluster of 16 eggs. They were under slabs of redwood on the ground. The eggs are in what would appear to be relatively early stages of development. The head-and-body and the limb buds are formed. Each embryo is coiled on the surface, apparently a meroblastic type of development like that characteristic of birds and in contrast to the mode of development in aquatic spawning Caudata and Salientia. The eggs measure 5.0 to 5.5 millimeters in diameter (across the yolk mass) and the outside of the apparently single jelly coat is 7.6 to 7.8 millimeters in diameter. The embryo fits closely into the vitelline capsule. When found, the eggs were nearly transparent; preservation has made the yolk mass opaque while the jelly coat remains clear.

"I am unable to see that these eggs are definitely peduncled as is the case with the eggs of both *Batrachoseps attenuatus* and *Aneides lugubris*. The eggs of *Ensatina eschscholtzii* here described seem to have come in contact with a substratum to which they adhered, and adjacent eggs are attached to one another. But this seems to have been due merely to the viscid nature of the jelly coat at the time of extrusion."

Remarks: The interesting problems still to be solved concerning this animal are its relationships with *croceater* where the two meet in the Northern Sierras, and which of the two actually occurs in the San Pedro Martir Mts. They are extremely close and it is not impossible that they intergrade.

Specimens seen 89, as follows:

Washington: Puget Sound 5 (U. S. N. M. No. 7022, 15479-80 (TYPES of *oregonensis*), 51020); Lake Cushman 1 (M. C. Z. No. 5897); Seattle 7 (U. S. N. M. No. 16169-75); Tanino 1 (U. S. N. M. No. 46014); Maysville 1 (U. S. N. M. No. 52094); Northwest Expl. Exped. 3 (A. N. S.).

Oregon: Portland 5 (U. S. N. M. No. 35851, 36081-4); McMinnville 1 (M. C. Z. No. 4075); no locality 1 (U. S. N. M. No. 53419).

California: Mt. Shasta, Mud Creek, 6,700 ft. 1 (U. S. N. M. No. 46015); Crescent City 1 (U. Mich. 58899); Petaluma 12 (U. S. N. M. No. 4004. M. C. Z. No. 1208); Fort Baker, Marin Co. 1 (U. S. N. M. No. 49898); Phœnix Gulch, Marin Co. 1 (U. S. N. M. No. 52077); Sausalito 30 (U. S. N. M. No. 49889-97, 50364-81, 51029-34, 51060-3, 53604, (A. N. S.); San Francisco 1 (U. S. N. M. No. 39476); San Mateo Co. 1 (U. S. N. M. No. 51331); Redwood City 3 (U. S. N. M. No. 46010-12); Mts. near Palo Alto 1 (M. C. Z. No. 2350); Berkeley 2 (U. S. N. M. No. 39446-7); Brookdale 8 (M. C. Z.

No. 4401-8); Filmore, Big Trees 2 (M. C. Z. No. 4410-11); Pacific Grove 1 (M. C. Z. No. 4409); Carmel 9 (Field M. N. H. No. 2868, A. M. N. H. No. 15623-6, 14451); Monterey 1 (U. S. N. M. No. 8000); Fresno 4 (U. S. N. M. No. 11764, 17650-2); Russian River 3 (A. N. S.); no locality 3 (M. C. Z. No. 1872, 1999).

It has also been recorded from the following additional localities: Washington: South Bend, Hoquiam, and Quiniault (Storer 1925). Oregon: Harbor, Marshfield, and Port Orford (Van Denburgh in litt.). California: Castle Rock, Whale Rock, and Requa, Del Norte Co.; Carlotta, Humboldt Co.; Sweet Briar, Shasta Co.; Agua Caliente, Sonoma Co.; Inverness, Marin Co. (Storer 1925); Mill Valley, Marin Co. (Van Denburgh 1898); Topanga Cañon, Los Angeles Co. (Rüthling 1915); Sierra Madre, Palmer's Cañon near Pomona, Los Angeles Co.; 10 miles N. W., San Bernardino (Storer 1925); Forest Home, San Bernardino Co., alt. 5,300 ft. (Grinnell and Camp 1917); "75 miles southeast of San Diego" (Lockington 1880).

The specimen recorded from Strawberry, Eldorado Co. (Storer 1925), as in the Mus. Cal. Acad. Sci., may be *croceater,* and may have served Stejneger and Barbour (1917) as basis for their record of *croceater* from that county.

HEMIDACTYLIUM TSCHUDI

1838 *Hemidactylium* Tschudi, Mem. Soc. Sci. Nat. Neuchâtel, p. 59 (type *scutatum*).
1848 *Cotobotes* Gistel, Naturgeschichte, p. 11 (substitute name).
1854 *Desmodactylus* Duméril and Bibron, Erp. Gén. 9, p. 117 (substitute name).

Diagnosis: Tongue attached in front; two premaxillae, nasal spines not fused; a fontanelle; septomaxilla present; maxilla normal; prefrontals present, not bordering nares; vomerine and parasphenoid series not continuous; condyles sessile; atlas normal; internal nares a notch in prevomer; eyes functional; gills of larvae with long rami; male with swollen snout and enlarged premaxillary teeth; tail constricted at base; toes 4-4, free; no palmar tubercles; terminal phalanges T-shaped; one species.

Range: Same as that of type species.

Note: *Dermodactylus* [*Desmodactylus*] *pinchonii* David 1871, Nouv. Arch. Mus. Nat. Hist. Paris 7, Bull., p. 95, from Moupin, Szechwan, China, does not belong to this genus. The animal should be called *Batrachuperus pinchonii,* and is a member of the family *Hynobiidae.*

HEMIDACTYLIUM SCUTATUM (SCHLEGEL)

1838 *Salamandra scutata* Schlegel, Amph., Fauna Japonica, p. 119; 1839, Abb. Amph., pl. 40, ff. 4-6.

1838 *Hemidactylium scutatum* Tschudi, Mem. Soc. Sci. Neuchâtel, p. 54, 94; Fitzinger 1843, Syn. Rept., p. 33; Baird 1849, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 286; Gray 1850, Cat. Batr. Grad. Brit. Mus., p. 41; Baird 1852, Rept. New York St. Mus. Nat. Hist., p. 21; Kennicott 1853, Trans. Illinois Agric. Soc. 1, p. 593; Hallowell 1856, Proc. Acad. Nat. Sci. Philadelphia, p. 11; 1858, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 366; Cope 1862, Proc. Acad. Nat. Sci. Philadelphia, p. 124; Verrill 1868, Proc. Boston Soc. Nat. Hist. 9, p. 249; Cope 1869, Proc. Acad. Nat. Sci. Philadelphia, p. 99; Smith 1882, Rept. Geol. Surv. Ohio 4, 1, p. 722; Davis and Rice 1883, Bull. Chicago Acad. Sci. 1, 3, p. 26; Hoy 1883, Geol. Wisconsin 1, p. 426; Davis 1884, Proc. Nat. Sci. Ass. Staten I. 1, p. 13; Hughes 1886, Bull. Brookville Soc. Nat. Hist. 2, p. 40 (eggs); Cope 1888, Journ. Morph. 2, pl. 22, f. 11 (otic region); 1889, Bull. U. S. Nat. Mus. 34, p. 130, f. 29, pl. 35, f. 5; Hay 1893, Rept. Indiana Geol. 17, p. 440; Gaines 1895, Amer. Nat. 29, p. 55; Sherwood 1895, Proc. Linn. Soc. New York 7, p. 21; Mearns 1896, Bull. Amer. Mus. Nat. Hist. 10, p. 323; Moore 1900, Proc. Acad. Nat. Sci. Philadelphia, p. 618 (vertebrae); Clark 1902, Rept. Michigan Acad. Sci. 4, p. 193; Hay 1902, Proc. Biol. Soc. Washington 15, p. 124; Britcher 1903,

Proc. Onondaga Acad. Sci. 1, p. 120; Henshaw 1904, Occ. Pap. Boston Soc. Nat. Hist. 7, 2, p. 3; Davis 1904, Proc. Nat. Sci. Ass. Staten I. 9, 2; Morse 1904, Proc. Ohio Acad. Sci. 4, p. 110; Clark 1905, Rept. Michigan Acad. Sci. 7, p. 109; Ditmars 1905, Journ. Amer. Mus. Nat. Hist. 5, p. 169, f. 5; Stone 1906, Amer. Nat. 40, p. 160; Fowler 1907, Rept. New Jersey Mus. 1906, p. 52, pl. 8; 1908, same, 1908, p. 393; Nash 1908, Vert. Ontario, p. 6; Kingsbury and Reed 1908, Anat. Rec. 2, p. 82; Hurter and Strecker 1909, Trans. Acad. Sci. St. Louis 18, p. 11; Reed and Wright 1909, Proc. Amer. Phil. Soc. 38, p. 402; Hurter 1911, Trans. Acad. Sci. St. Louis 20, p. 80; Ruthven 1911, Rept. Michigan Acad. Sci. 12, p. 114; Thompson and Thompson 1912, Rept. Michigan Acad. Sci. 12, p. 216; 1912, Michigan Geol. and Biol. Survey 10, 3, p. 34, pl. 1, f. 1; Piersol 1913, Nat. Hist. Toronto, p. 243; Surface 1913, Bull. Pennsylvania Dept. Agric. 3, 3-4, p. 92, f. 6; Boyle 1914, Copeia 9; Deckert 1914, Copeia 13, p. 3; Evans 1915, Proc. U. S. Nat. Mus. 49, p. 354; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 26; Fowler 1917, Copeia 40, p. 14; Mattern and Mattern 1917, Copeia 46, p. 64; Stejneger and Barbour 1917, Check List, p. 14; Dunn 1918, Copeia 53, p. 19; 1918, Bull. Mus. Comp. Zoöl. 62, p. 459; Bishop 1920, New York Mus. Bull. 219, pl. 1-7 (habits); Löding 1922, Alabama Mus. Pap. 5, p. 12; Blanchard 1922, Occ. Pap. Mus. Zoöl. U. Michigan 126 (habits); 1923, Amer. Nat. 57, p. 262 (habits); Bishop 1923, Copeia 118, p. 66; Stejneger and Barbour 1923, Check List (2), p. 9; Humphrey 1925, Journ. Morph. 41, p. 4 (germ cells).

1854 *Desmodactylus scutatus* Duméril and Bibron, Erp. Gén. 9, p. 118.

1882 *Batrachoseps scutatus* Boulenger, Cat. Batr. Grad. Brit. Mus. (2), p. 59.

1844 *Salamandra melanosticta* Gibbes, Boston Journ. Nat. Hist. 5, p. 89, pl. 10 (Abbeville, S. C.).

1854 *Desmodactylus melanostictus* Duméril and Bibron, Erp. Gén. 9, p. 119.

Type: Not known to exist.

Type locality: Nashville, Tenn.

Range: From Massachusetts to Michigan, Georgia and Texas.

Diagnosis: A salamander with four toes; basal constriction of tail; tongue attached in front; belly white with black spots.

Description: Adult male, Northampton, Mass., Smith College collection; 14 costal grooves; 3 costal folds between appressed toes; head width 6 in length from snout to vent; head length 3 in length of body; head a blunt oval; snout swollen, especially below nostrils; eye as long as its distance from tip of snout; outline of upper jaw sinuous; angle of jaw beneath hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 5, 1 in order of length, 1 not free; toes 3, 2, 5, 1 in order of length; vent papillate; tail missing; vomerine teeth 8 in series, separated from fellow by width of

nares, and from parasphenoids by 4 times width of nares; latter in two patches, beginning at hinder fourth of eyesocket; premaxillary teeth enlarged, pointed, piercing lip and visible when mouth is closed; light

24. Eastern United States, showing localities for Hemidactylium scutatum.

brown above, dark gray on sides, white pigment below; black dots on sides of belly; total length 28, head 7, body 21, tail 0.

Variation: A female, same data, has unswollen snout; no papillae in vent; tail terete, longer than body; 9-10 vomerine teeth, series separated from parasphenoids by twice width of nares; premaxillary

teeth not enlarged; black dots all over belly; a light line at upper edge of dark lateral band; total length 65, head 7, body 27, tail 31.

A young specimen, same data, has 2 costal folds between appressed toes; total length 31, head 4, body 15, tail 12.

A larva, same data, from eggs collected May 23, and killed June 21, has dorsal fin to back of neck; gills with long rami and few filaments; upper row of larval spots coalesced with the row of the opposite side so as to produce a wavy-edged dorsal light band as in *Plethodon dorsalis;* middle row of larval spots not evident; lower row present; limbs not well developed; fingers 4, toes 3, total length 13 mm.

Bishop (1920) mentions a female 75 mm. long.

Habits: The eggs were first mentioned by Hughes (1886) who found them "in moss at the roots of trees that stood near ponds," in the vicinity of Brookville, Ind.

Bishop (1920) describes the eggs and development from batches found near McLean, New York. The following quotations are from his paper:

"On May 14, 1919, the writer, while sifting for spiders with Prof. C. R. Crosby, of Cornell University, found the eggs of the four-toed salamander with the female coiled about them in the bogs of the Mud pond basin near McLean, N. Y.

"The McLean bogs are part of a series extending in a northeast-southwest direction between Ithaca and Cortland, N. Y. Originally of considerally area, the actual sphagnum-heath formations are now of comparatively small extent and diminishing with the encroachment of grass and shrub and tree. Mud pond itself is surrounded by bushy swamps and grass bogs with occasional patches of sphagnum and other mosses scattered about the margin among the clumps of shrubs. A characteristic shrub, herb and sphagnum association on the border of this pond may be presented as a typical habitat of *Hemidactylium* during the period of deposition and incubation of the eggs.

"The common woody shrubs are represented by clumps of redosier dogwood (Cornus stolonifera), hoary alder (Alnus incana), and an occasional shad bush (Amelanchier sp.). A few seedlings of arrow-wood (Viburnum dentatum) and vines of Clematis virginiana find root among the larger shrubs. The herbaceous plants consist principally of small groups of meadow rue (Thalictrum polygamun), white violet (Viola blanda), touch-me-not (Impatiens biflora), water pennywort

(Hydrocotyle americana) and scattered single plants of the cuckoo flower (Cardamine pratensis). In the open water spaces between, the marsh marigold (Caltha palustris) and other bog-loving forms are scattered. Rank growths of sphagnum and other mosses cover the roots and bases of the shrubs and in these masses of moss the four-toed salamander lays her eggs.

"In every instance the eggs were found buried to a depth of 3 or 4 inches in the moss and within 6 inches of the water. In every instance the female was found either partly coiled upon the eggs or about them. When disturbed the female often made an effort to escape by burrowing in the moss but sometimes she seemed inclined to stay with her eggs. It is almost impossible to find the eggs of *Hemidactylium* without disturbing their position somewhat in removing the covering of moss, but in general it may be stated that they are disposed in a mass and are stuck firmly together and to rootlets and stems of moss.

"The first lot of eggs found (May 14th) contained ninety, but were probably the complements of two females as a second was seen but not captured. Subsequent observations on the number of eggs deposited strengthens this conjecture. On May 27th, A. H. Wright and the writer again visited the bogs, and other specimens were found in like situations within a few feet of the former. At this time, a female and her eggs, about fifty, and a female without eggs were taken. A third specimen was left as found partly coiled about her eggs. On June 30th A. H. Wright found that this female and her brood had departed. On May 28th Henry Dietrich, of Cornell University, while collecting at the Ringwood bogs near Etna, N. Y., found one adult and two half-grown four-toed salamanders in the moss near water. One week before two adults were taken by him in the same place.

"Unlike the eggs of *Desmognathus fuscus, Plethodon cinereus* and some others, those of *Hemidactylium* are not stalked but cling together and to the surrounding moss by the adhesiveness of their gelitanous coverings.

"In size they vary from 2.5 to 3 mm. in diameter and are inclosed by two, at least, gelatinous envelops which give them a total diameter of 4.5-5 mm. depending to a considerable extent on the amount of moisture present and consequent absorption. The outer of the two distinct envelops is comparatively thin, tough, and elastic; the inner, more fluid in its consistency like clear jelly. In some stages of de-

velopment it was possible to distinguish a thin vitelline membrane closely surrounding the embryo and separating it from the more fluid envelop.

"Larvae taken May 30th, with gills fully developed and kept in moss saturated with water, left the eggs June 19th and retained the gills without apparent reduction until June 23rd when they died. The young then were retained 20 days in the egg with the gills fully developed. Larvae of the original lot of eggs arrived at the gill stage June 6th, escaped from the eggs June 12th, and in the one specimen that survived, considerable reduction was evident June 19th. Specimens with gills in this case remained within the egg only 6 days.

"Thirty days were required to complete the development of larvae in the eggs if, as estimated, they had been deposited 3 days before being discovered. In one specimen the gills were reduced to half their original size in 7 days more. If this be considered a normal reduction, then complete loss of the gills might be accomplished in an additional week or two and the total length of time required for development and transformation be limited to a period of about 5 weeks. The fact that the female found with eggs May 27th had disappeared with her brood some time before June 30th affords some evidence that the whole period of transformation may be accomplished within the limits estimated. The length of time, however, probably varies considerably as indicated by the retention of gills in larvae kept in saturated moss."

Blanchard (1922) reported finding the eggs in similar situations in southern Michigan, and in 1923 he published an account of his observations on the life history. He was able to correct Bishop's surmises as to the length of incubation and larval life.

His summary of the life history follows:

"1. The eggs are laid, in the vicinity of Ann Arbor, about the middle of April or a little later, in clusters imbedded in the rhizoids of moss and roots of grass from 2½ to 7 inches above water.

"2. Eggs will not be found unless the breeding site is directly adjacent to a piece of wooded land, nor will adults be found in woods not adjacent to a suitable breeding site.

"3. The period from egg deposition to hatching is about five weeks.

"4. There is an aquatic larval life of about six weeks.

"5. The newly transformed individuals have dark gill patches, a

dark line extending from the snout to behind the eye, and disproportionately short tails without basal constrictions.

"6. Development during the rest of the season results in obliteration of the dark gill patches, a slight fading of the postocular line, the development of the caudal constrictions characteristic of the adult, and an increase in the proportional length of the tail.

"7. The fully adult form and sexual maturity are not attained the first season."

On May 23, 1924, I found a female with about 19 eggs in an exactly similar situation near Northampton, Mass. The eggs were well developed. Larvae hatched from these eggs were still aquatic on June 21, when they were killed.

Remarks: This species anatomically is probably derived from some ancestor of the present *intermedius-elongatus-dorsalis-cinereus* group of *Plethodon.* Its fourteen costal grooves relate it to *intermedius* rather than to the others, which are more specialized and elongate. It has a longer series of vomerine teeth than any of the four *Plethodons* and is hence more primitive in that respect. In coloration it is less primitive in dorsal pattern than is *dorsalis,* but more so than the other three. In ventral coloration it is unique. The belly is *pigmented* with white. The four toes and basal constriction of the tail are obvious specializations in which it goes beyond any *Plethodon.*

In life history it is more primitive than any known *Plethodon,* in having an aquatic larval stage. This aquatic larval stage is more specialized than that of any of the other members of the family. The larva is unique in having a dorsal fin and in hatching with the hind legs in a rudimentary state. It thus resembles the larvae of *Ambystomidae* and *Pleurodelidae.* This resemblance is due to the fact that all three have larvae which live in still water. The situation is primitive in the case of *Ambystoma* and *Triturus,* but obviously secondary in the case of any Plethodont, and the resemblance is convergence and looks very much like a case of reversed evolution, the larva of the specialized *Hemidactylium* taking on the characters of the larva of forms much more primitive than any of its own immediate ancestors.

The animal thus offers a very curious combination. Specialized to terrestrial life in the adult, primitive in having an aquatic larval stage,

and apparently primitive but really highly specialized in the exact nature of that aquatic larval stage.

Specimens seen 103, as follows:

Canada: St. Catherine's, Ontario 1 (U. S. N. M. No. 4730a).

Massachusetts: Ipswich 2 (M. C. Z. No. 7626-7); Beverly 1 (M. C. Z. No. 2086); Lynn 6 (M. C. Z. No. 1692); Medford 1 (M. C. Z. No. 1837); Brookline 1 (M. C. Z. No. 2639); Sherborn 1 (M. C. Z. No. 2003); Middlesex Fells 2 (M. C. Z. No. 7051-2); Springfield 6 (M. C. Z. No. 2088); Northampton 15 (S. C.).

New York: Highland Falls 1 (U. S. N. M. No. 23210); Ithaca 1 (U. S. N. M. No. 39405).

New Jersey: Swartzwood Lake 1 (A. N. S.); Plainfield 1 (M. C. Z. No. 2305); Cape May 1 (A. N. S.).

Pennsylvania: Fallsington 1 (A. N. S.); Haverford 2 (E. R. D.); Carlisle 5 (U. S. N. M. No. 4088); Cumberland Valley 1 (M. C. Z. No. 1444); Meadville 4 (U. S. N. M. No. 4089); no locality 1 (M. C. Z. No. 201).

Ohio: Ripley 1 (U. S. N. M. No. 4093).

Indiana: Brookville 1 (A. N. S.); Lake Maxinkuckee 5 (U. S. N. M. No. 42601-4).

Illinois: Chicago 1 (A. N. S.); Northfield 9 (U. S. N. M. No. 4094); Shermerville 1 (Field No. 2851).

Michigan: Livingston Co. 1 (M. C. Z. No. 4837); Ingham Co. 6 (M. C. Z. No. 9022-7).

Wisconsin: Racine 1 (U. S. N. M. No. 39445).

Maryland: Plummer's I. 2 (U. S. N. M. No. 61130. 63284).

Virginia: Dyke 2 (U. S. N. M. No. 44199-200); Mt. Vernon 6 (U. S. N. M. No. 19278, 48602, 61943-6); Chilesburg 1 (U. S. N. M. No. 48921).

South Carolina: Charleston 1 (M. C. Z. No. 1199); no locality 1 (M. C. Z. No. 4400).

Alabama: Duncanville 1 (U. Ala.).

Louisiana: Indian Mound 2 (Viosca).

Arkansas: Hot Springs 2 (U. S. N. M. No. 37050, 59019); Garland Co. 1 (U. S. N. M. No. 59020).

Texas: No locality 3 (M. C. Z. No. 206).

It has also been recorded from the following additional localities:

Humber Valley, Toronto (Piersol 1913); Gloucester, Mass. (Cope 1889); New Haven, Conn. (Verrill 1868); these localities in New York: Elizabeth I. in Lake George, Altamont, Etna, McLean, and Orient Point, L. I. (Bishop 1922); Jamaica North, L. I. (Boyle 1914); Staten I. (Davis 1884); Westchester Co. (Deckert 1914); Coxsackie (Baird 1852); Palisades (Ditmars 1905); Hudson Highlands (Mearns 1898); Onondaga Co. (Britcher 1903); Duck Lake and Oswego, Wayne Co. and Buffalo (Wright and Moesel 1919); in New Jersey: Fort Lee and Harrington (Sherwood 1895); Princeton (Fowler 1907); in Pennsylvania: Summit Lawn, Lehigh Co. (Mattern and Mattern 1917); Wayne (Surface 1913); Londongrove, Chester Co. (Cope 1862); in Indiana: Vincennes (Gaines 1895); Terre Haute, Irvington, and North Manchester

(Hay 1893); in Michigan: Eaton Co. (Clark 1902); Washtenaw Co. (Ruthven 1911); Chippewa Co. (Thompson and Thompson 1912); Gogebic Co. (Evans 1915); Jackson Co., and Oakland Co. (Blanchard 1923); Abbeville, S. C. (Gibbes 1844); Anderson, S. C., Georgia (Cope 1889); Nashville, Tenn. (Schlegel 1838); Bourbon, Crawford Co., Mo. (Hurter 1911). The specimens (U. S. N. M. No. 4090) recorded by Cope (1889) from Riceboro, Ga., are in reality individuals of *Triturus viridescens*.

ANEIDES BAIRD

1849 *Aneides* Baird, Icon. Encycl. 2, p. 257 (type *lugubris*).
1849 *Anaides* Baird, l. c., p. 256, 460 (not of Westwood, Proc. Ent. Soc. London 1841).
1887 *Autodax* Boulenger, Ann. Mag. Nat. Hist. (5), 19, p. 67 (substitute for *Anaides*).

Diagnosis: Tongue attached in front; one premaxilla, nasal spines not fused, a fontanelle; septomaxilla present; maxilla with hind portion knife-edged and edentulous; prefrontals present, not bordering naris; vomerine and parasphenoid series not continuous; internal naris a notch in prevomer; condyles sessile; atlas normal; eyes functional; no aquatic larval stage; no marked sexual dimorphism; tail not constricted at base; toes 4-5, free; terminal phalanges curved, Y-shaped; no palmar tubercles; four species.

Range: British Columbia to Lower California; Cumberland Plateau.

Key to species of *Aneides:*

A. Maxillary and mandibular teeth not flattened.
  B. Mottled black and brownish, Cumberland Plateau . . . *aeneus* 205
  B B. Black, California . . . . . *flavipunctatus* 220
A A. Maxillary and mandibular teeth flattened.
  B. Brown, not mottled, light below . . . . . *lugubris* 211
  B B. Mottled brown and black, dark below . . . . . *ferreus* 208

ANEIDES AENEUS (COPE AND PACKARD)

1881 *Plethodon aeneus* Cope and Packard, Amer. Nat. 15, p. 878; Cope 1889, Bull. U. S. Nat. Mus. 34, p. 143, f. 32; Rhoads 1895, Proc. Acad. Nat. Sci. Philadelphia, p. 402; Stejneger 1906, Proc. U. S. Nat. Mus. 30, p. 561, ff. 2, 6; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 25; Stejneger and Barbour 1917, Check List, p. 14; Dunn 1918, Copeia 53, p. 19.
1923 *Aneides aeneus* Dunn, Proc. New England Zoöl. Club 8, p. 39; Stejneger and Barbour 1923, Check List (2), p. 18; Holt 1924, Copeia 135, p. 94.

Type: Acad. Nat. Sci. No. 10461, collected by E. D. Cope.

Type locality: Nickajack Cave, Tennessee (near Chattanooga).

Range: From Nickajack Cave, Tenn., to Baileysville, W. Va. Cumberland and Kanawha sections of Alleghany Plateau.

Diagnosis: An *Aneides* with mottled black and brownish coloration, and with unflattened teeth.

Description: U. S. Nat. Mus. No. 18025, adult female, South Pittsburg, Tenn.; 14 costal grooves; appressed toes meeting; head width 5 in length from snout to vent; head length 3 in length of body; head oval; eye as long as its distance from tip of snout; snout not swollen; outline of upper jaw slightly flexuous as seen from side, and bending up rather sharply beneath eye; angle of jaw back of hind angle of eye, and somewhat turned upwards; both eyelids fitting under a fold of skin behind; a groove from hind angle of eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length, webbed at base, tips of second, third and fourth swollen; toes 3, 4, 2, 5, 1, in order of length, webbed at base, tips of all but first swollen; tail longer than head and body, circular in cross-section; anal lips smooth; vomerine series not continuous with parasphenoid, about 7 teeth in series, beginning behind middle of naris, separated from its fellow by width of naris and from parasphenoids by twice that distance; latter in a single incompletely divided patch, beginning opposite first third of eyesocket; teeth on maxilla only to level of anterior border of naris, rest of maxilla knife-edged and edentulous; teeth on mandible only to level of middle of eye, last four much enlarged; somewhat faded, on a cream-colored ground the entire dorsal surface is so marbled with chocolate that the ground color appears as a light mottling on a dark ground; total length 109 mm., head 13, body 41, tail 55.

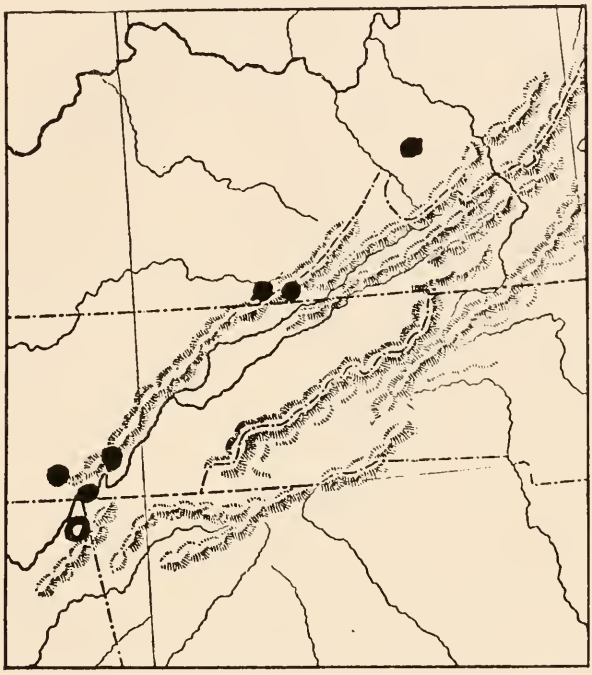
Variations: A male, A. N. S. No. 19775, Pine Mt., Ky., has the appressed toes overlapping; head length 2½ in length of body; anal lips lined with papillae; 3 premaxillary teeth enlarged and piercing lip; very dark chocolate marbled with greenish white over whole dorsal surface; below a dusting of minute black dots on an uncolored surface produces a cream-colored effect (specimen was taken less than six months before description was written); total length 108 mm., head 15, body 38, tail 55.

M. C. Z. 7327, a female from Baileysville, W. Va., has 8-9 teeth in the vomerine series, which is separated from its fellow by half the width of the naris. A female, Amer. Mus. No. 1835, no locality, has the parasphenoids in two patches, eleven mandibular and eleven maxillary teeth.

The largest specimen, a female, A. N. S. 4315, Sawyer's Springs, Tenn., is 122 mm. total length, head 14. The smallest specimen has

the same data and measures 31.5 mm. (This last specimen is stated by Rhoads (1895) to measure "twenty-five millimeters").

Habits: Rhoads (1895) says "found associating with *glutinosus* on the Cumberland table land near Chattanooga. . . . The specimens were taken under the bark of rotten tree stumps about three feet from the ground."



25. Southern mountains, showing localities for Aneides aeneus.

The type and the Virginia specimen seem to have come from caves.

Remarks: This form resembles *Aneides ferreus* of the West. It has not the flattened, enlarged teeth of that form, and is probably the most primitive member of the genus. It has nothing to do with *flavipunctatus,* although it as well as *aeneus* were originally described as *Plethodon* because of their unflattened teeth. The maxillary dentition is incorrectly figured in Stejneger (1906). It is but fair to say

that this figure was designed to show the vomerine and parasphenoid dentition, which are quite accurately portrayed.

The confluence or separation of the parasphenoid patches seem individual variation.

Specimens seen 10, as follows:

No locality 1 (Amer. Mus. 1835).
Tennessee: Nickajack Cave 1 (A. N. S. 10461, TYPE); Sawyer's Springs 2 (A. N. S. 4315); South Pittsburg 1 (U. S. N. M. 18025).
Virginia: Dolomite caves of Cumberland Mts., Lee Co. 1 (U. S. N. M. 16660).
Kentucky: Pine Mt., Harlan Co. 1 (A. N. S. 19875).
West Virginia: Baileysville 3 (U. S. N. M. 33621-33622, M. C. Z. 7327).

It has also been recorded from Sand Mt., Jackson Co., Alabama (Holt 1924).

ANEIDES FERREUS (COPE)

1869 *Anaides ferreus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 109; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 53; Yarrow 1883, Bull. U. S. Nat. Mus. 24, p. 159.

1889 *Autodax ferreus* Cope, Bull. U. S. Nat. Mus. 34, p. 185, f. 45; Van Denburgh 1916, Proc. California Acad. Sci. (4), 6, 7, p. 216.

1917 *Aneides ferreus* Grinnell and Camp, U. California Publ. Zoöl. 17, 10, p. 135, f. 2; Stejneger and Barbour 1917, Check List, p. 21; 1923, id. (2), p. 18; Storer 1925, U. California Publ. Zoöl. 27, p. 117.

Type: U. S. N. M. No. 14451.

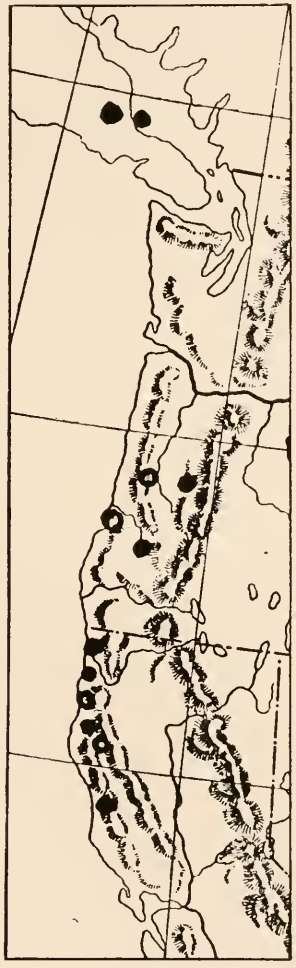
Type locality: Fort Umpqua, Oregon.

Range: Vancouver Island to Comptche, Mendocino Co., Cal. Northern part of Pacific Border Province.

Diagnosis: An *Aneides* with flattened teeth; belly dark; mottled above with dark and light.

Description: U. S. N. M. No. 55278, adult male, Vancouver I.; 15 costal grooves; one costal fold between appressed limbs; head width 6 in length from snout to vent; head length 3⅔ in length of body; head a blunt oval; eye as long as its distance from tip of snout; outline of upper jaw strongly convex as seen from side, turned upwards below eye; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3 2, 4, 1 in order of length, 1 very short; toes 4, 3, 5, 2, 1 in order of length; vent lined with papillae; tail imperfect; vomerine teeth about 4 in

series, running in and back from inner hind corner of nares, separated from its fellow by width of nares and from parasphenoids by length of series; latter in a single patch beginning opposite middle of eye-socket; brown, lighter below; blotched and marbled above with dark-



26. Pacific Coast, showing localities for Aneides ferreus.

N

er, below with light flecks on a darker ground; total length 73, head 15.5, body 57, tail 10.

Variation: A female, U. S. N. M. No. 52276, same data, has no papillae in vent, tail terete, shorter than body; vomerine teeth 6 in series which meets its fellow posteriorly; maxillary teeth 4, flattened; mandibular teeth 4, flattened; premaxillary teeth smaller, not flattened; brown above mottled with darker; mottled on sides with lighter; tail bicolor; total length 98, head 14, body 45, tail 39.

A young specimen, Cal. Acad. Sci. No. 28502, Comptche, Cal., has the appressed toes meeting; there is a red spot on the thigh, the forearm, the parotoid region, and the snout, and a red stripe on the dorsum of the tail; total length 34, head 6, body 16, tail 12.

The tail is occasionally longer than the body. The vomerine series may number as many as 8 teeth (Cal. Acad. Sci. No. 44907, Orick, Cal.).

The largest female, Cal. Acad. Sci. No. 28505, Comptche, Cal., has total length 113, head 16, body 59, tail 48. The largest male seen is the one described above.

Habits: Van Denburgh (1916) says of two specimens from Requa, Cal.: "They were taken from the rotten wood of a dead tree in which they were living some 20 feet above the ground."

Remarks: Fairly close to *lugubris,* but a smaller species with shorter legs, fewer mandibular and maxillary teeth, and a different coloration. In color it much resembles *aeneus* of the Cumberlands. The ranges of the two possibly overlap a little as I have seen *lugubris* from Mendocino City and *ferreus* from Comptche, and the latter is slightly southeast of the former, but in general the range of *ferreus* is different and more northern.

Specimens seen 24, as follows:

British Columbia: Denman I. 3 (U. S. N. M. No. 52275-7); Union Bay 2 (U. S. N. M. No. 29615, 29617); Vancouver I. 2 (U. S. N. M. No. 55278-9).

Washington: Puget Sound (Yarrow 1883).

Oregon: Vida 1 (U. S. N. M. No. 54109); Fort Umpqua 1 (U. S. N. M. No. 14451 TYPE).

California: Requa 1 (Cal. Acad. Sci. No. 29102); Orick 5 (M. C. Z. No. 5933, Cal. Acad. Sci. No. 44907, 44909-10, 44913); Alton 1 (Cal. Acad. Sci. No. 28939); Comptche 8 (Cal. Acad. Sci. No. 28499-506).

It has also been recorded from Bayne I., B. C., Marshfield and Elmira, Ore., and Trinidad and Carlotta, Cal. (Van Denburgh 1916).

ANEIDES LUGUBRIS (HALLOWELL)

1833? *Triton tereticauda* Eschscholtz, Zoöl. Atlas 5, p. 14 (Fort Ross, Cal.).

1849 *Salamandra lugubris* Hallowell, Proc. Acad. Nat. Sci. Philadelphia 4, p. 126.

1849 *Aneides lugubris* Baird Icon. Encycl. 2, p. 257; Hallowell 1856, Proc. Acad. Nat. Sci. Philadelphia, p. 10; 1858, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 345; 1859, Pacific R. R. Survey, Rept. 10, 1, p. 23, pl. 7, f. 2; Wilder 1896, Anat. Anz. 12, p. 191 (lunglessness); Snook and Long 1914, U. California Publ. Zoöl. 11, p. 511 (spermatogenesis); Dunn 1918, Bull Mus. Comp. Zoöl. 62, p. 463; Noble 1921, Bull. Amer. Mus. Nat. Hist. 44, p. 5; Stephens 1921, Trans. San Diego Soc. Nat. Hist. 3, p. 59.

1850 *Tarichа? lugubris* Gray, Cat. Batr. Grad. Brit. Mus., p. 26 (skull).

1853 *Anaides lugubris* Baird and Girard, Proc. Acad. Nat. Sci. Philadelphia, p. 302; Girard 1858, U. S. Expl. Exped. Herp., p. 8, pl. 1, ff. 26-33; Baird 1859, Pacific R. R. Survey, Rept. 10, 4, p. 13, pl. 30, f. 4; Cope 1869, Proc. Acad. Nat. Sci. Philadelphia, p. 109; Strauch 1870, Mem. Acad. Imp. Sci. St. Petersbourg (7), 16, 4, p. 75; Wiedersheim 1877, Morph. Jahrb. 3, pl. 25, ff. 104-6; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 52; Yarrow 1883, Bull. U. S. Nat. Mus. 24, p. 22, 158; Emmel 1921, Anat. Rec. 21, p. 56 (erythrocytes); 1924, Amer. Journ. Anat. 33, p. 351, pl. 1, f. 29, pl. 5, ff. 45, 47, 49 (erythrocytes); Vaillant 1882, Bull. Soc. Phil. Paris (7), 6, p. 183 (vertebrae); 1886, same (7), 8, p. 42 (vertebrae).

1887 *Autodax lugubris* Boulenger, Ann. Mag. Nat. Hist., p. 67; Cope 1888, Journ. Morph. 2, pl. 22, f. 15 (otic apparatus); 1889, Bull. U. S. Nat. Mus. 34, p. 183, f. 44, pl. 27, ff. 1-4, pl. 35, f. 3, pl. 48, f. 15; Keeler 1892, Zoe 3, p. 151, 154; Ritter and Miller 1899, Amer. Nat. 33, p. 691 (habits); Ritter 1903, Amer. Nat. 37, p. 883 (habits); Miller 1906, Amer. Nat. 40, p. 741; Hilton 1909, Amer. Nat. 43, p. 53; Van Denburgh and Slevin 1914, Proc. California Acad. Sci. (4), 4, p. 139; Rüthling 1915, Copeia 25, p. 62; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 23.

1917 *Aneides lugubris lugubris* Grinnell and Camp, U. California Publ. Zoöl. 17, p. 134, f. 2; Stejneger and Barbour 1917, Check List, p. 21; Schmidt 1922, Bull. Amer. Mus. Nat. Hist. 46, p. 633; Stejneger and Barbour 1923, Check List (2), p. 18; Grinnell and Storer 1924, Yosemite Fauna, p. 653; Storer 1925, U. California Publ. Zoöl. 27, p. 124, pl. 9, f. 20.

1850 *Ambystoma punctulatum* Gray, Cat. Batr. Grad. Brit. Mus., p. 37 (Monterey, Cal.).

1886 *Plethodon crassulus* Cope, Proc. Amer. Phil. Soc. 23, p. 521 (California); 1889, Bull. U. S. Nat. Mus. 34, p. 147, f. 34; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 25.

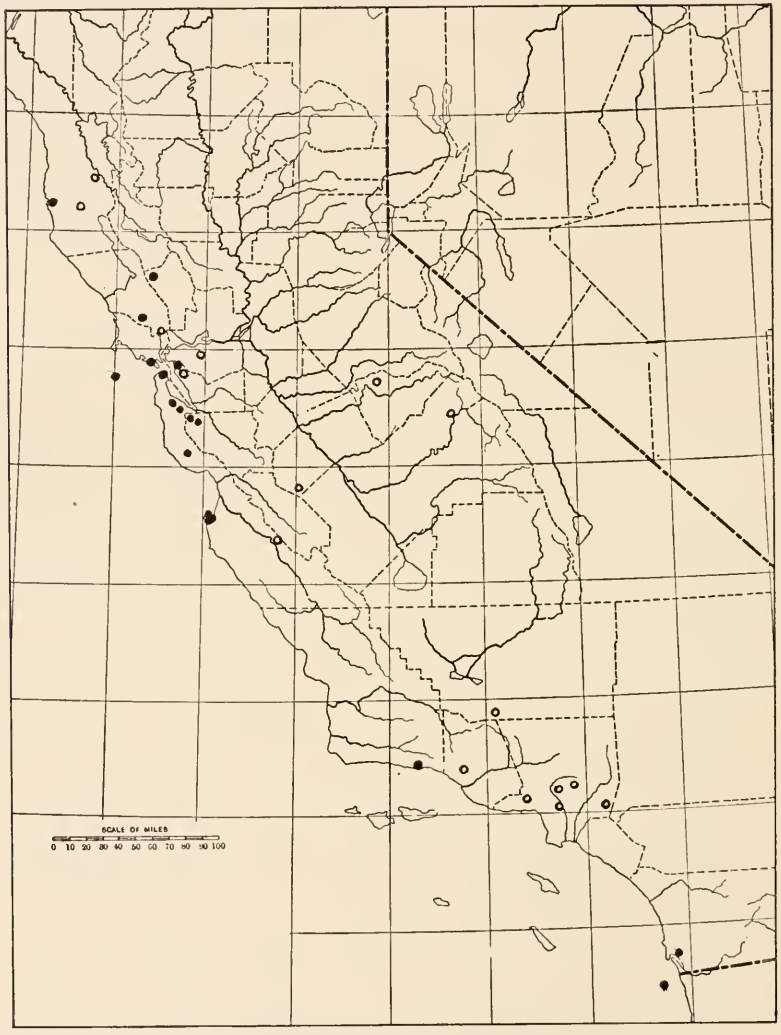
1905 *Autodax lugubris farallonensis* Van Denburgh, Proc. California Acad. Sci. (3), 4, p. 5, pl. 2 (South Farallon I., Cal.); Van Denburgh and Slevin 1914, same (4), 4, p. 134.

1917 *Aneides lugubris farallonensis* Grinnell and Camp, U. California Publ. Zoöl. 17, p. 135; Stejneger and Barbour 1917, Check List, p. 21; 1923, same (2), p. 18; Storer 1925, U. California Publ. Zoöl. 27, p. 140.

Type: A. N. S. No. 1257.

Type locality: Monterey, Cal.

Range: From Mendocino Co., Cal., to Coronados Is., Baja Cal. Pacific Border Province.



27. California, showing localities for Aenides lugubris.

Diagnosis: An *Aneides* with flattened teeth, coloration nearly uniform above with light dots, light below.

Description: U. S. N. M. No. 51041, adult male, Sausalito, Cal., 14 costal grooves; appressed toes meeting; head width 4¾ in length from snout to vent; head length 2½ in length of body; head a blunt oval; eye as long as its distance from tip of snout; outline of upper jaw crooked, bent up from below eye; upper eyelid fitting in a groove in lower behind so that a part of lower lid projects backwards spur-fashion; a groove from eye to gular fold; limbs well developed; fingers 3, 4, 2, 1 in order of length, webbed at base, tips swollen; toes 3, 4, 5, 2, 1 in order of length, webbed at base, tips swollen; tail longer than body, oval in cross section, turned down and flattened at tip; vomerine teeth 4-5 in series, beginning in and back from inner edge of nares, separated from its fellow by width of nares and from parasphenoids by length of series; latter in two narrow patches, beginning at middle of eyesocket; mandibular teeth 8, only on anterior part, long and flattened; maxillary teeth 6, similar in shape and position; premaxillary teeth 9, not flattened; lead black above, light cream below; dots of the lighter color on upper surface of limbs, sides of body, and on tail; total length 144, head 22, body 56, tail 66.

Variation: U. S. N. M. No. 51039, adult female, same data, has six teeth in the vomerine series, which meets its fellow posteriorly; 10 mandibular, and 6 maxillary teeth; total length 130, head 19, body 52, tail 59.

Some specimens have the parasphenoids in a single patch. The tail may be shorter than the body. Occasional specimens lack the light spots as do U. S. N. M. No. 55384, 52819, 50747. Two of these, 55384 and 50747, are mottled light and dark above somewhat as in *ferreus*. Other specimens have numerous light spots. The Coronados Islands specimens have very few light spots, and the Farallon Island ones have many, but specimens from both islands can be matched perfectly by mainland individuals.

The largest and smallest specimens seen are:

U. S. N. M. No.	50745	♂	Total 152,	head 25,	body 59,	tail 68	Stanford, Santa Clara Co.
"	52619	♀	" 151	" 24	" 61	" 66	Luscol, Napa Co.
"	4047a	yg.	" 35	" 6	" 14	" 15	Petaluma, Sonoma Co.

Habits: The arboreal nature of this animal will be set forth in the following quotations. Ritter and Miller (1899) described the finding of a female with a batch of eggs at Berkeley.

"They consisted of an adult female and nineteen embryos, all in practically the same stage of development and well advanced. They were found slightly beneath the surface of the ground and close under the oversetting base of a large palm tree.

"The student who found them stated that he noticed, as he was loosening the earth about the roots of the palm, a hole which he at first supposed to be a gopher hole, but on removing a little of the soil at this point the salamander and her eggs were brought to light. He says that on being uncovered and disturbed she 'squeaked like a mouse.' This sound was one of the first things that attracted his attention. This squeak is frequently produced by adults when first taken, but rarely while they are in confinement. They were on the south side of the tree; and as the ground in this palm grove is kept perfectly free from other vegetation, and the spot where the animals were located receives the full force of the sun's heat during the whole middle portion of the day, it will be readily understood, particularly when it is considered that this region had received no rain for at least two months, that the place was about as dry as it can become. There is a creek bed about fifty meters from the tree, but this had been dry for three months at least.

"When brought to the laboratory in a box with some earth, the salamander was partly coiled around the eggs, and in this position she seemed at first inclined to remain, since she returned to the eggs several times after being removed. The following morning, however, she left them and appeared to have entirely deserted her charge.

"As already said, there were nineteen embryos in our batch. Each was contained in a gelatinous capsule and was firmly anchored to a clump of earth by a narrow peduncle, about 8 mm. long, composed of the same material as the capsule. The peduncles were attached to the earth close together; in fact, their adhesive, expanded, attached ends were more or less confluent.

"The peduncles were twisted, and each appeared to be hollow. The capsules were rather thin and seemed decidedly leathery when the eggs first reached us — as was always afterwards the case if the eggs were permitted to desiccate to any extent. After having imbibed water, however, which they did very eagerly, they became much thicker and more transparent and showed clearly their gelatinous nature.

"The capsules were almost perfect spheres, and in what might be considered their normal state as regards imbibed water, were about 6 mm. in diameter."

They also describe the broad, three-lobed allantoic gills, which are later mentioned and figured by Emmel (1924) from a batch of 14 eggs found on July 14, 1920. Later, Ritter (1903) described the more usual habitat in the following paragraphs.

"In caring for the oaks (Quercus agrifolia) on the campus of the University of California this summer the trees have been subjected to a treatment they have never before received. This has consisted in the careful cleaning out of the decayed wood and foreign accumulations from all accessible corners and cavities, and of painting the walls of these with coal tar, and then filling the smaller cavities with Portland cement. The men engaged in the work have taken from these holes about 100 specimens of the salamander itself, and twelve bunches of its eggs.

"The form-habit of this oak commonly spoken of as the 'live oak' is well-known to all who are acquainted with the environs of San Francisco Bay. The tree is short trunked, and diffusely branched, the contorted branches being wide spreading rather than high reaching, so that a height of fifty feet is exceptional. The salamanders are found as high in the trees as there are holes suitable for their dwelling places. Some have been taken from holes at the height of thirty feet at least. In some of the largest cavities as many as twelve individuals were found; more commonly, however, a hole contained two, or occasionally but a single one.

"Several facts indicate pretty clearly that in some cases all the inhabitants of a single chamber were close of kin, constituted in fact, a family. Where a considerable number of individuals were together it invariably happened that the majority were small, and the particularly significant thing is that the small ones were all of about the same size, their length being about 50 mm. Besides these individuals of minimum size there occurred in nearly all the inhabited holes whether containing the small ones or not, a few, usually two individuals of maximum size. Then in addition to those of maximum and minimum size, there were frequently found, in the same hole, several others of intermediate size. Those of minimum size constituted in all probability a single litter, and were at this season of the year, viz.,

early autumn, yearlings. Furthermore, I strongly suspect they were frequently, if not always, the young of the individuals of maximum size occurring in the holes with them. If this interpretation of the meaning of the presence of the small individuals together is correct, it would follow that they had probably never yet in the year of their existence left the tree in which they were hatched. It is hardly to be supposed that they could make nightly excursions to the ground and return to the same hole to spend the day. As was pointed out in the paper above cited the species is distinctly nocturnal. As a rule the cavities occupied by the animals while of ample dimensions for creatures of their size, had but very small orifices by which entrance could be effected from the outside world. Frequently the opening was not more than three or four centimeters across, barely larger than necessary to admit the body of the full grown animal. But for the directions the workmen had received to carefully clean to the bottom all the cavities they could find, even though the entrances had to be cut larger in order that the remedial treatment might be administered, the dwelling places of the salamanders would surely not have been found. Wide mouthed cavities were rarely found occupied.

"The egg clusters, each containing from twelve to eighteen eggs, and each egg with its own pedicle about two centimeters in length were usually suspended from an overhanging surface where the parent was able to bring its own body into contact with them. This it did by winding itself around the egg clusters in much the same way that several other species of *Urodela* are known to do. More than one bunch of eggs rarely occurred in the same hole.

"Several observations make the question of the extent to which parental care of the eggs and young may go in this species, one of much interest. In the first place it appears that the male and female may both together participate in the office. Probably a majority of the cavities in which eggs were found contained two animals of maximum size. In some instances at least these were certainly male and female. Whether this was always or usually the case or not I am not yet able to say, since this point not having been raised until most of the animals taken had been put together in a common terrarium, it was impossible to tell which were inmates of the same hole. It may be noted in this connection that there are no secondary sexual distinctions in this species, so far as I have been able to determine.

"Again the animal seems to exercise more or less of an active defence either of itself or of its eggs or both. Its unusually large teeth has been a subject of comment by nearly all zoölogists who have written about it, and in the paper by Miller and myself attention was called to Cope's statement that 'this Autodax is probably more capable of inflicting a bite than any other of the American salamanders.' At that time we were obliged to say, however, that 'we had not been able to get any positive evidence on the point.' The workmen who found most of the specimens in the holes tells me, without having been questioned with reference to the matter, that the old ones with the eggs usually 'showed fight' when he first came upon them. He says they seized a stick or his finger when held toward them with decided energy. I have, furthermore, the direct testimony of another person, in this instance a student well experienced in out of door natural history, that an individual once found by him under a rock or log in the field, seized his finger in a distinctly vicious manner."

Storer (1925) quotes from the MS. of Miller as to the contents of faecal pellets of two specimens: "They showed hard parts of insects, legs, wing covers, etc., numbers of amoeboid bodies, spores of fungi, and *chips of wood*. I had previously suspected the animal of eating the softened wood and fungus. The richness and abundance of the damp fungus would make it an easy food. The presence of oak fibers in a number of faecal pellets and abundance of fungus spores possibly gives the dark color to the stomach contents and the faeces. One piece of wood was 3 mm. in length and another 4 mm. The mass of the faeces is made up of wood fiber, spores and spore masses . . . A mass of wood fiber and fungus was brought in from the tree where so many [35] salamanders were found together and examined for insect forms. Three or four small spiders and a couple of . . . insects were all that could be found. The amount of such life in a cavity that is so thoroughly peopled as the one last seen would be entirely insignificant as a food supply for the whole colony. The fungus spores and wood fibers are identical with those taken from the faeces."

Grinnell and Storer (1924) describe the habits of those taken in the Yosemite valley near Coulterville. "In the Sierras we found it at but the one locality mentioned above, chiefly beneath logs and stones in pastures and woodlands. Two adults were found in the interior of a charred and slightly decayed yellow pine log which was lying on a

sun-baked manzanita-covered hillside at the margin of the yellow pine forest; one of the animals was found in the nest of a wood rat; and another was discovered in a gopher burrow in the ground beneath a wood rat's house."

Storer (1925) says: "I have found the species above ground only once, when two individuals of small size (approximately 42 and 70 millimeters in total length) were discovered under bark on an oak stub at a height of about 4 feet (1.25 meters) above ground.

"*Aneides* lives both on the ground and in trees. Practically all the specimens in collections save those taken by Ritter and Miller have been found on the ground. The animals take shelter under stones, or boards which have lain on the ground for some time, in rotted stumps and logs, and at least two have been taken in nests of the brown-footed wood rat *(Neotoma fuscipes)*. The salamanders are to be found in these habitats during the daytime, from the beginning of the rainy period (late September or early October) until about May. During the midsummer months . . . they disappear. Whether the animals ascend the trees only during the breeding season is unknown. The arboreal retreats need to be investigated during the winter rainy period in order to determine this point. Neither young nor adults are to be found on the ground during the summer dry period, and many individuals (35 in one instance: Miller, MS.) were found to occupy single cavities above ground. One group was found at a height of 30 feet above the ground. Miller (MS.) says that these salamanders are great travelers. There is the possibility that the terrestrial stock of *Aneides* simply retires to holes in the ground during the summer dry period . . . That some of the individuals do remain on the ground is indicated by the three records given below of eggs found at the ground surface in the late summer or early autumn months.

"This salamander breeds during the summer months, egg deposition taking place in July and August and possibly in late June. The first eggs were discovered about July 24 (1898) on the campus at Berkeley when a group of 19 was found in dry soil at the base of a palm 50 meters from the nearest creek. Development was already advanced when the eggs were found . . . In the summer of 1903, 12 egg clusters of 12 to 18 each were taken from cavities in live oaks on the campus . . . Five eggs, apparently of this species, were found by

C. L. Camp beneath stones in a rock quarry near Napa, Napa County, on September 1, 1916. Two lots of eggs numbering 17 and 16 respectively were discovered by Mr. Halstead G. White in hollow logs on Stonewall Creek, 6 3/10 miles southwest of Soledad, Monterey County, on July 23 and 24, 1919. On July 14, 1920, Dr. V. E. Emmel took a lot of 14 eggs from beneath a flower box in the Botanical Gardens on the campus at Berkeley.

"Parental attention seems to be necessary for at least two reasons. Eggs left to themselves usually perish through desiccation; the parent individual therefore provides moisture, either from her skin or from the bladder, which in the case of adults in attendance upon eggs is usually found to be distended with fluid. Adult individuals in attendance upon eggs brought into the laboratory have occasionally been found to devour their own eggs."

Remarks: In spite of its close relationship to *ferreus,* and the occasional occurrence of a *ferreus*-like type of coloration in *lugubris,* the two remain well distinct where the ranges meet or overlap in Mendocino County, and the abberrant markings obviously do not indicate intergradation.

I cannot regard the Farallon race as different enough for recognition.

Specimens seen 239, as follows:

California: Mendocino Co.: Mendocino 8 (M. V. Z. No. 4937-44); Napa Co.: Luscol 8 (U. S. N. M. No. 52819-26); Calistoga 6 (U. S. N. M. No. 53611-13, 53618-20); Sonoma Co.: Petaluma 57 (U. S. N. M. No. 4047, M. C. Z. No. 1204); Marin Co.: Sausalito 9 (U. S. N. M. No. 51023, 51028, 51030, 51032, 51035-7, 51064-5); San Francisco Co.: San Francisco 16 (U. S. N. M. No. 4010, 4030, 4036, 11576, M. C. Z. No. 192, A. N. S.), Red Rock 3 (U. S. N. M. No. 53608-9, 55384), San Andreas Lake 2 (U. S. N. M. No. 52057-8); South Farallon I. 4 (M. C. Z. No. 8166, U. S. N. M. No. 4036, 57379-80); San Mateo Co.: San Mateo 1 (M. C. Z. No. 2066), Menlo Park 2 (U. S. N. M. No. 35744-5) 2 (U. S. N. M. No. 51330, 51332); Santa Clara Co.: Palo Alta 22 (M. C. Z. No. 2347, 2351, 2549, Field No. 688, 692, 694), Mt. View 10 (A. N. S., U. S. N. M. No. 21169, M. C. Z. No. 1046-7, 1749), Stanford 12 (U. S. N. M. No. 23637-41, 28258-61, 50745-7), Santa Cruz Mts. 1 (U. S. N. M. No. 23664); Alameda Co.: Berkeley 2 (U. S. N. M. No. 13943, 13947); Santa Cruz Co.: Brookdale 4 (M. C. Z. No. 4449-52); Monterey Co.: Monterey 8 (U. S. N. M. No. 4021, 6585, A. N. S. No. 1257 TYPE); Carmel 4 (M. C. Z. No. 2544, Field No. 2869); Pacific Grove 10 (M. C. Z. No. 4439-48); Santa Barbara Co.: Santa Barbara 9 (A. N. S., M. C. Z. No. 4453-60); San Diego Co. 1 (U. S. N. M. No. 26490); no locality

28 (A. N. S., M. C. Z. No. 216, 1842, 2076, 4284-94, U. S. N. M. No. 9447 TYPE *Plethodon crassulus*, 11424, 14475).
Baja California: Coronados I. 9 (U. S. N. M. No. 52419-27).

It has also been recorded from the following additional localities: "Columbia River" (Baird 1859), probably erroneous. California: Comptche, Willits, Napa, Oakland, Moraga Valley, 22 miles southwest of Los Banos, Stonewall Creek, North Fork (Storer 1925); 3 miles northeast of Coulterville (Grinnell and Camp 1917); Fort Tejon (Cope 1889); 3 miles southeast of Lankershim, 3 miles south of Nordhoff, Pasadena, Sierra Madre (Storer 1925); Santa Monica Mts. (Rüthling 1915); Sequoia Mine, Sorrento Mt. (Stephens 1921).

Orcutt's (1885) record for the Falls of the San Diego River refers to *Triturus torosus*, according to Grinnell and Camp (1917).

ANEIDES FLAVIPUNCTATUS (STRAUCH)

1870 *Plethodon flavipunctatus* Strauch, Mém. Acad. Sci. St. Pétersbourg (7), 16, p. 71.
1925 *Aneides flavipunctatus* Storer, U. California Publ. Zoöl. 27, p. 119.
1883 *Plethodon ïëcanus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 24 (Shasta Co., Cal); Townsend 1887, Proc. U. S. Nat. Mus. 10, p. 240.
1886 *Anaides ïëcanus* Cope, Proc. Amer. Phil. Soc. 23, p. 526.
1889 *Autodax ïëcanus* Cope, Bull. U. S. Nat. Mus. 34, p. 187, f. 46; Van Denburgh 1895, Proc. California Acad. Sci. (2), 5, p. 776 (habits); Dice 1916, U. California Publ. Zoöl. 16, 17, p. 306; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 23.
1917 *Aneides ïëcanus* Grinnell and Camp, Univ. California Publ. Zoöl. 17, p. 135; Stejneger and Barbour, Check List, p. 21; Dunn 1918, Bull. Mus. Comp. Zoöl. 52, p. 463; Stejneger and Barbour, 1923, Check List (2), p. 18.

Type: In Petrograd Museum?

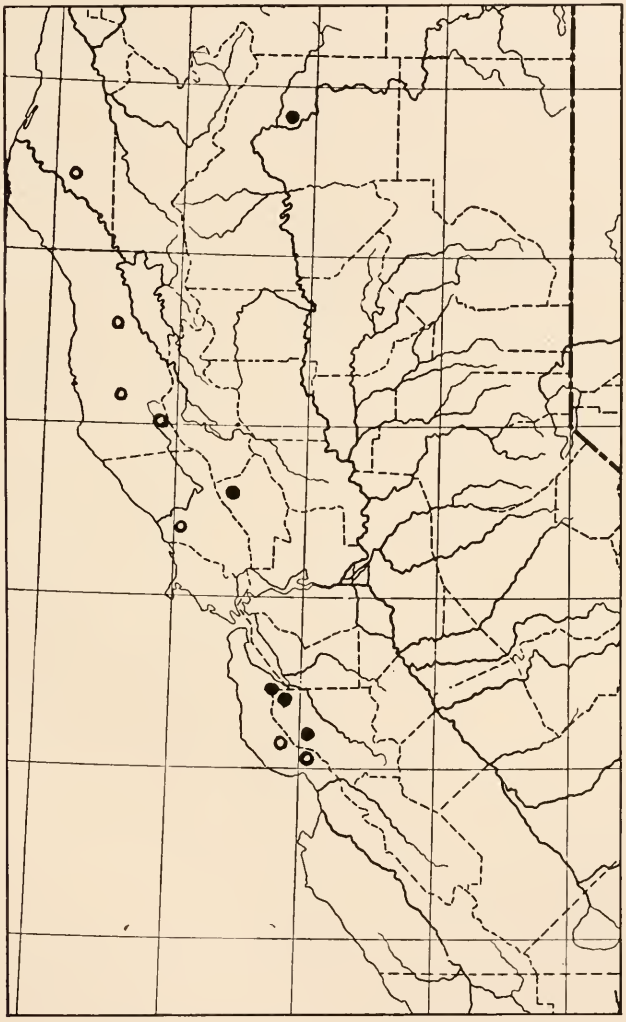
Type locality: New Albion, California [probably Sonoma Co. (Storer 1925)].

Range: Northern California; Coast Range, Klamath, and Southern Cascade Mountains.

Diagnosis: An *Aneides* with unflattened teeth, color black.

Description: U. S. N. M. No. 14596, McCloud River, Cal., adult male, costal grooves 14, 3 costal folds between appressed toes; head width 5½ in length from snout to vent; head length 3⅓ in length of body; head oval; eye as long as its distance from tip of snout; angle of jaw back of hind angle of eye; outline of upper jaw crooked as seen from side, bending up sharply beneath eye; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 2, 5, 1 in order of length;

vent lined with papillae; tail shorter than body; circular at base, flattened at tip; vomerine teeth 4 in series, beginning behind inner edge of nares, running in and back, separated from its fellow by width of nares and from parasphenoids by length of series; latter in an incom-



28. California, showing localities for Aneides flavipunctatus.

pletely divided patch beginning at middle of eyesocket; black above and below; total length 118, head 17, body 56, tail 45.

Variation: A female, U. S. N. M. No. 28265, Stanford, Cal., has head width 6½ in length from snout to vent; 4 costal folds between the appressed toes; no papillae in vent; total length 117, head 16, body 51, tail 50.

The tail may be slightly longer than the body. The costal grooves may number 15, and the appressed toes may be separated by 5 costal folds. The smallest and largest specimens seen are as follows:

A. M. N. H. No. 15627 Los Gatos, Cal.	♀	Total	130,	head	18,	body	57,	tail	55
Cal. Acad. Sci. 13390 Los Gatos, Cal.	♂	"	141	"	19	"	60	"	62
U. S. N. M. No. 21170 Mt. View, Cal.	yg.	"	39	"	6	"	18	"	15

The maxillary and mandibular teeth number 4 and 3 respectively in an adult male, U. S. N. M. No. 57406, from Sta. Clara Co., Cal.

Habits: Van Denburgh (1895) gives an account of the breeding habits. He says they are found "under boards, decaying logs, and stones in the vicinity of running water, and in the drain from a spring." It is a "nocturnal forager" and the tail is prehensile. A female with 15 eggs was received from Los Gatos, Cal., on July 23, 1895. The eggs were "6 mm. in diameter, spherical, with a thin, tough, gelatinous sheath. . . . Each of the sheaths was drawn out, at one place, into a slender peduncle, which was attached to a basal mass of the same gelatinous substance. . . . The salamander and eggs were found under the platform in front of a barn, in dry earth next the foundation wall, and about 15 inches or more below the surface. The ground had been filled in and was full of spaces. There was some rotten wood near the eggs and one or two smaller salamanders were near. About two times as many eggs were found as sent. There was no water within 10 or 15 feet."

Storer (1925) says: "A female of this species and seven pedunculated eggs were taken at Laytonville, Mendocino County, on July 1, 1913. They were found 9 inches (228 millimeters) below the surface of the ground in a cellar. These eggs were deposited in a group and attached by their peduncles to the damp earth."

Remarks: I am inclined to think Storer is right in considering that Strauch's *flavipunctatus* is this species. I had long realized that the name referred to an *Aneides,* but never having seen one of this species with light spots, I was inclined to hesitate, especially as Strauch de-

scribes the tail as less compressed than that of Gray's *Ambystoma punctulatum,* i.e., than that of *lugubris.* Now, however, I have reëxamined the original description, and find that the ratio of the combined length of fore and hind legs to length of body indicates very strongly that Strauch had this short-legged species rather than the long-legged *lugubris.* The short legs, black color, and unflattened teeth render this form very distinct.

Specimens seen 23, as follows:

California: Sta. Clara Co.: Stanford 1 (U. S. N. M. No. 28265); Sta. Cruz Canon 2 (M. C. Z. No. 2348); Mt. View 1 (U. S. N. M. No. 21170); Los Gatos 12 (Cal. Acad. Sci. No. 13390-1, 13394, 40462, 40465-6, M. C. Z. No. 2545, A. M. N. H. No. 14468-9, 15627-9); no locality 2 (U. S. N. M. No. 57406-7); Napa Co.: Calistoga 2 (U. S. N. M. No. 53614-5); Shasta Co.: Baird 3 (A. N. S. No. 14061 TYPE *iĕcanus,* U. S. N. M. No. 13791, 14596).

It has also been recorded from the following additional localities:

California: Humboldt Co., Ukiah, Mendocino Co. (Grinnell and Camp 1917); Comptche and Laytonville, Mendocino Co., Sweet Briar Camp, Shasta Co., Skaggs Springs and Camp Meeker, Sonoma Co. (Storer 1925); New Albion (Strauch 1870); Glenwood and Boulder, Santa Cruz Co., Stevens Cr., Santa Clara Co. (Van Denburgh 1895).

The record of Dice (1916) of this animal from "southeastern Washington" is based in reality on individuals of *Ambystoma macrodactylum,* so I am informed by Dr. Grinnell, who has reëxamined the specimens.

BATRACHOSEPS BONAPARTE

1839 *Batrachoseps* Bonaparte, Fauna Italica, Fsc. 26 (type *attenuatus*).

Diagnosis: Tongue attached in front; one premaxilla, nasal spines not fused, a fontanelle; septomaxilla present; maxilla normal; prefrontals missing; internal naris a notch in prevomer; vomerine and parasphenoid series not continuous; condyles sessile; atlas normal; eyes functional; no aquatic larval stage; no marked sexual dimorphism; tail not constricted at base; toes 4-4, free; terminal phalanges T-shaped; no palmar tubercles; six forms.

Range: Southern Alaska to Lower California; Mexico(?).

Key to forms of *Batrachoseps*.

A. Black, tail twice as long as head and body, 21 costal grooves, Alaska . . . . . *caudatus* 232

AA. Not black, tail not twice as long as head and body, Oregon to Mexico.

B. Leg extending over 6 costal folds, vomerine teeth in a series, sides as light as back, 16-20 costal grooves . . . *pacificus* 236

B B. Leg extending over 4 costal folds.

C. Back lighter than sides, vomerine teeth in patch, 18-21 costal grooves . . . . . *attenuatus* 224

C C. Back not lighter than sides.

D. Vomerine teeth in patch.

E. Larger, inner finger and toe normal, 18-20 costal grooves *major* 234

E E. Smaller, inner finger and toe much reduced, 19-21 costal grooves . . . . . *catalinae* 239

D D. Vomerine teeth in series, smaller, inner finger and toe normal, 18-20 costal grooves . . . . . *leucopus* 241

BATRACHOSEPS ATTENUATUS ATTENUATUS (ESCHSCHOLTZ)

1833 *Salamandrina attenuata* Eschscholtz, Zoöl. Atlas 5, p. 1, pl. 21, ff. 1-14.

1839 *Batrachoseps attenuatus* Bonaparte, Fauna Italica, Fsc. 26; Fitzinger 1843, Syst. Rept., p. 33; Baird 1849, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 288; Gray 1850, Cat. Batr. Grad. Brit. Mus., p. 42; Cooper 1858, Pacific R. R. Rept. 12, 3, p. 8, pl. 31, f. 5; Hallowell 1858, Journ. Acad. Nat. Sci. Philadelphia (2), 4, p. 348; Cope 1869, Proc. Acad. Nat. Sci. Philadelphia, p. 98;

Cooper 1870, Amer. Nat. 4, p. 756; Wiedersheim 1877, Morph. Jahrb. 3, pl. 25, ff. 94-5 (skull); Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 60; Cope 1883, Proc. Acad. Nat. Sci. Philadelphia, p. 28; 1888, Journ. Morph. 2, pl. 22, f. 12 (otic region); 1889, Bull. U. S. Nat. Mus. 34, p. 127, f. 28, pl. 35, f. 4; Wilder 1896, Anat. Anz. 12, p. 189 (lunglessness); Eisen 1897, Proc. California Acad. Sci. 3, 1 (erythrocytes); 1900, Journ. Morph. 17, p. 1 (spermatogenesis); Jannsens and Dumez 1903, Le Cellule 20, p. 419 (spermatogenesis); Snyder 1904, Biol. Bull. 7, p. 280 (exper. phys.); Hilton 1909, Amer. Nat. 43, p. 53; Jacob 1910, Blätt. aqua. terr. Kunde. 21, p. 280, 298, 329 (habits); Burke 1911, Amer. Nat. 45, p. 413 (eggs); Rüthling 1915, Copeia 25, p. 62; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 26; Grinnell and Camp 1917, U. California Publ. Zoöl. 17, p. 136; Stejneger and Barbour 1917, Check List, p. 13; Dunn 1918, Bull. Mus. Comp. Zoöl. 62, p. 459; Emmel 1920, Anat. Rec. 18, p. 232 (erythrocytes); 1921, Anat. Rec. 21, p. 56 (erythrocytes); Noble 1921, Bull. Amer. Mus. Nat. Hist. 44, p. 5 (septomaxilla); Steiner 1921, Anat. Anz. 53, p. 513 (tarsus); Stephens 1921, Trans. San Diego Soc. Nat. Hist. 3, p. 59; Snyder 1923, Copeia 121, p. 86 (eggs); Stejneger and Barbour 1923, Check List (2), p. 8; Emmel 1924, Amer. Journ. Anat. 33, p. 351, pl. 2, pl. 3, f. 24-6, pl. 4, f. 27-33, pl. 5, f. 46, 48, 50 (erythrocytes, eggs, young); Grinnell and Storer 1924, Yosemite Fauna, p. 654 (eggs); Storer 1925, U. California Publ. Zoöl. 27, p. 89, pl. 9, f. 21, 24.

1869 *Batrachoseps nigriventris* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 98 (Ft. Tejon, Cal.); 1889, Bull. U. S. Nat. Mus. 34, p. 129.

Type: Not definitely known.

Type locality: Environs of Bay of San Francisco, Cal.

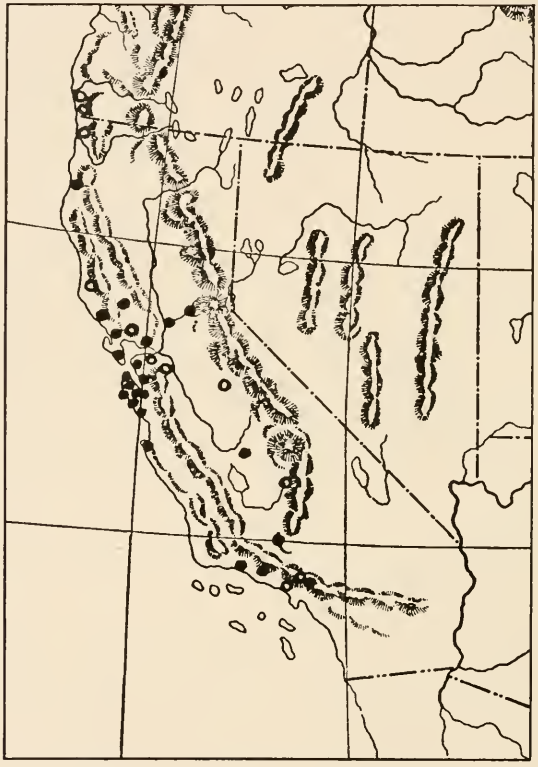
Range: Oregon to Los Angeles Co., Cal., Pacific Border Province, and Sierra Nevada.

Diagnosis: A *Batrachoseps* with light dorsal surface and dark sides; vomerine teeth in a patch; 18-21 costal grooves; leg extending over 4 costal folds.

Description: M. C. Z. No. 2282, adult female, San Francisco, Cal.; 21 costal grooves; 12 costal folds between appressed toes; arm and leg each reach over 4 costal folds; head width 9⅓ in length from snout to vent; head length 5½ in length of body; head oval; eye longer than its distance from tip of snout; both eyelids under a fold of skin behind; outline of upper jaw sinuous; angle of jaw back of hind angle of eye; limbs weak; fingers 3, 2, 4, 1 in order of length, 1 not free; toes 3, 2, 4, 1 in order of length, tip of 1 free; vent with smooth lips; tail longer than head and body, terete; vomerine teeth in an irregular patch; this runs in and back from inner edge of nares, separated from its fellow by twice width of nares and from parasphenoids by four

times width of nares; latter in two patches beginning at middle of eyesocket; a light dorsal band, sides dark grayish brown; belly light mottled with dark; total length 145, head 9, body 50, tail 86.

Variation: A male from Berkeley, Cal., M. C. Z. No. 4394, has 20 costal grooves; papillae in vent; enlarged premaxillary teeth; total length 77, head 8.5, body 41.5, tail 27 (imperfect).



29. California and Oregon, showing localities for Batrachoseps attenuatus attenuatus.

Specimens from near San Francisco have usually 19-20 costal grooves. Out of 48 individuals from that general region 2 had 21 costal grooves, 22 had 20, 19 had 19, and 5 had 18. Further south, in the region around Monterey, the number averages smaller. Of 31

specimens from there, 1 had 20 costal grooves, 8 had 19, 20 had 18, and 2 had 17. There is thus a distinct approach to the count of *pacificus* of the islands. Hubbs collected a number of specimens and made notes on them which he has very kindly allowed me to see. From around San Francisco of 15 animals 1 had 21 grooves, 6 had 20, 7 had 19, and one had 18. From near Monterey of 91 specimens 5 had 19, 54 had 18, 31 had 17, and 1 had 16.

There are no other important variations.

Habits: Burke (1911) published the first account of the habits as seen at Stanford. His account follows:

"The first eggs obtained were discovered by T. Kimura during January, 1906. They were found partly buried in depressions under rocks on a moist hillside. On January 5, 1907, the author found some eggs under a log in a moist ravine well up in the hills. The eggs were deposited in small pockets in the ground: 21 were in one group and 10 in another group about 2 feet distant, while 4 were scattered between, suggesting that all were deposited by a single female. These eggs were round or slightly oval and about 6 mm. in diameter. Development was well advanced. The first individual to issue from the egg appeared on January 28, and was 17 mm. in length and of a dull black color. By May 22 it had doubled in length and was 35 mm. long. The majority of the eggs when found were covered with fungus and failed to develop. This suggests that they may have been under abnormal conditions. It seems very likely that the majority of the eggs of this species are deposited just beneath the surface of the ground, as is the case with earthworm eggs and so escape detection. Diligent search at the proper season should settle this question.

"*Batrachoseps attenuatus* disappears from this region with the approach of the dry season and appears suddenly in the fall after the first heavy rains. I have been informed that it can be obtained at any season in the moist coast region near Pacific Grove."

Snyder (1923) has described another batch of eggs as follows — the animal having been taken at Palo Alto:

"The eggs which came into the hands of the present writer were in the form of very firm, gelatinous globules, securely attached, one to another, much like loosely strung beads.

"Each egg measured 6.3 millimeters in diameter. The capsule was almost perfectly transparent and of a pale amber color. When placed

in water and viewed by transmitted light, the embryo appeared to be enclosed by two distinct capsules, one within the other. The outer, when dissected away, was dense or rigid enough to maintain its globular form. Its substance was amber-colored, whilst the capsule within was colorless. Extending from each pole of the outer capsule was a filament by which it was attached to the adjoining egg. The filament did not appear to be hollow. The inner capsule could not be made to revolve within the outer one, although the two readily separated.

"The embryo could be observed through the second capsule as clearly as if it had been embedded in optical glass. It was curled about a large straw-colored mass of yolk, the tail passing to one side of the head in one case, a little below and posterior to it in another. At this time the legs were well developed and large trilobed gills were present. It will be recalled that *Batrachoseps* is terrestrial, and is never seen in the water. It could not be determined whether the gills were functioning as organs of respiration.

"The second enclosing capsule was dissected away, but unlike the first one, it fell into a shapeless mass. It was removed with difficulty, being very elusive, easily evading the edge of the scalpel. It was now seen that the embryo was within still another capsule, the substance of which was very viscid and adhered closely to an inner membrane. When the latter was laid bare it quickly shrunk as if a contained fluid had passed out, compressing the embryo from all sides into the least possible space. When the membrane was ruptured the body of the embryo straightened out like a released spring.

"At the stage here described the embryo measured about 10 millimeters in length. When it grew to about 13 millimeters, and the yolk mass was considerably reduced, the gills were much shortened. Later, when the embryo was about 16 millimeters long and the remnant of the yolk, enclosed within the body, was just visible through a long abdominal slit, the gills had nearly disappeared. Shortly after this, April 3, one salamander hatched. It measured 16.5 millimeters. No gills were visible."

Emmel (1924), working at Berkeley, found other eggs and described and figured the remarkably rudimentary condition of the gills, the animal having a compensation for its abortive respiratory apparatus in its non-nucleated erythrocytes.

"On March 7, 1920, we were fortunate in securing a set of *Batrachoseps* eggs. Anyone who has ever attempted to obtain eggs of this species can readily appreciate the difficulty with which they are found. Since there is, as far as I am aware, only one previously recorded report of their discovery (Burke, '11) it seems desirable to give a brief account of the present case. As in Burke's account, the eggs in our own case were also located in a moist area of ground, in a depression on a hillside near Berkeley, California. They were discovered by my son and myself in the moist earth, beneath a heavy plank which was rather deeply embedded in the soil. We secured a total of fifty-three eggs. This represents a relatively large number as compared with Burke's account, in which the maximum number in a group was twenty-one. Two adults found with the eggs appeared greatly excited by our intrusion, but finally made their escape before they could be caught. The eggs were clumped together in a shallow groove about 6 inches in length. Each egg was encased in a gelatinous capsule, each spherical capsule and egg having a total diameter of 5 to 6 mm. These egg capsules were either attached by a narrow pedicle to small pieces of wood or other solid objects, or were attached to small thread-like rootlets which were directly embedded in the capsule itself so that the eggs had something of the relation of beads strung upon bits of thread.

"The eggs were transferred to the laboratory and kept on moist cotton in a jar whose mouth had been covered with gauze. The embryos when found were already quite well advanced in development. Several specimens removed from the egg about a week later measured 13 to 14 mm. in total length. The fore and hind limbs were of about equal length and measured 1½ mm. There was no trace of a dorsal tail fin, the tail being essentially of a cylindrical form as in the adult. Several days later a number of specimens hatched from the egg, and the gills, which were present within the egg, underwent a rapid atrophy."

Grinnell and Storer (1924) mention the animal in the following terms: "At Snelling, on January 8, 1915, an old rotted log half buried in river-washed débris was broken open by one of our party, and 3 of these salamanders were found inside. Two others were discovered in slight depressions in the ground beneath the log. In the interior of this same log was found a group of about 15 small eggs, each of which

was in a gelatinous capsule to which was attached a slender thread of similar material."

Storer (1925) says: "On the University of California campus at Berkeley this salamander is normally abundant. In 1921 watch was kept of suitable retreats for the species adjacent to the Museum of Vertebrate Zoölogy, and fully 50 of the animals were present under boxes and boards within 20 feet of the building. They disappeared entirely in early May, but with the first rains of the autumn (November) they reappeared in customary numbers. Upon visiting a certain box under a grove of Pittosporum trees 15 or more were usually to be found during the daytime. In late February all of the *Batrachoseps* occurring there were collected; within ten days a dozen or more additional animals were found. On successive days the population was different in numbers and distribution suggesting that these salamanders do not have so fixed a 'homing' response as do toads. On the night of March 7 I visited the box at 11 p. m. and found only two salamanders present. The ground and leafy débris adjacent were examined carefully with the aid of an electric flash lamp but none of the animals could be seen. Next morning the space under the box was found to harbor the usual number of salamanders; in addition to these, two individuals were found on the surface of the ground away from the box, but under some leaves. On December 13 after the population had been established above ground for some time, the hiding place was examined at 6.15 p. m. after full darkness. There were no salamanders under the box, but by the aid of the flash lamp, one was seen out on a path where none could be found during the daytime. On December 28 more than 20 *Batrachoseps attenuatus* besides four large *Ensatina eschscholtzii* were found under this particular box."

Remarks: The forms of *Batrachoseps* present rather a problem to the systematist, the question being how many forms to recognize and on what characters. There is apparently no overlapping of ranges and the species is one with a number of more or less emphasized local races, and with very indefinite and variable characters. The vomerine dentition, the coloration, the number of costal grooves, and the length of the legs are the characters which have been used.

The vomerine teeth are in patches in *attenuatus, major,* and *catalinae;* in series in *leucopus, caudatus* and *pacificus*. Thus the peripheral forms retain the primitive arrangement.

In color the black *caudatus* and *attenuatus* with its light dorsal band differ from the more uniform gray above and light below of the other four. Here the primitive form is *attenuatus*.

In leg length (and in general in all save color) *pacificus* is the most primitive. *Major* probably has longer legs than *attenuatus*, but also fewer costal folds so that in each case the leg reaches over four folds.

The costal groove count varies widely in each single form. 18-21 in northern *attenuatus*, 16-20 in southern. The smallest known amount of variability is 18-20 in *major* and in *leucopus*. There is therefore a great practical difficulty in recognizing any race which differs only in this character, and I therefore do not recognize the southern *attenuatus* as distinct. In the other characters individual variation is much less. Furthermore no other character is so dependent on the personal equation of the observer. Thus I am fairly sure that Van Denburgh has habitually counted one less groove than I have, probably by his omitting the axillary which is often obscure. His counts and mine for *pacificus* agree much more closely if a groove be subtracted from all my counts or one be added to his. As regards Hubbs' counts we seem to agree on northern *attenuatus*, but on southern *attenuatus* our counts would coincide if a similar shift were made. This does not attempt to deny the actual average difference between *attenuatus* from San Francisco and *attenuatus* from Monterey, but as only 25% of the individuals could be positively identified as belonging to one or the other form I think it improper to recognize this difference in nomenclature. Other races herein recognized, whether of *attenuatus* or of other species, can be individually identified in at least 75% of the cases.

The status of *attenuatus* is that of a form showing primitive color and specialization in most other characters. It is uncertain whether it intergrades with *major* or not. It seems not to do so in the region around Claremont, nor at Fillmore.

The types of *nigriventris* were examined by Fowler and myself (1917) and found not to differ from *attenuatus* and in some respects not to agree with the original description of the form. The name therefore lapses.

Specimens seen 394, as follows:

California: Eureka 1 (U. S. N. M. No. 46149); Russian R. 1 (A. N. S.); Eldorado Co. 1 (U. S. N. M. No. 4043); Petaluma 11 (M. C. Z. No. 1195, U. S. N.

M. No. 4017); Balinas Bay, Marin Co. 1 (U. S. N. M. No. 14454); Phenix Gulch, Marin Co. 7 (U. S. N. M. No. 52064, 53605-7, 55376-7); Sausalito 40 (U. S. N. M. No. 49883-5, 49903-33, 51027); San Francisco 62 (M. C. Z. No. 156, 2282, A. N. S., U. S. N. M. No. 49899-902, 52033-4, 52056, 53342-58, 53610, 57333); Calistoga, Napa Co. 2 (U. S. N. M. No. 53616-7); Lake Chebot, Solano Co. 5 (U. S. N. M. No. 52814-8); Sacramento 2 (M. C. Z. No. 1198); Berkeley 7 (M. C. Z. No. 4391-5, U. S. N. M. No. 53601-2); Oakland 1 (A. N. S.); Stanford 72 (U. S. N. M. No. 23642-67, 28267-80, 50752-83); San Jose 10 (M. C. Z. No. 1197, 1840, 4605-6); Palo Alto 46 (M. C. Z. No. 2358, 2548, Field No. 689, U. S. N. M. No. 46133); San Mateo Co. 5 (U. S. N. M. No. 57337-41); San Pedro Point 4 (U. S. N. M. No. 33119-22); Menlo Park 2 (U. S. N. M. No. 35746-7); San Mateo 19 (M. C. Z. No. 1194, 2111, 4398); Redwood City 6 (U. S. N. M. No. 46019-24); Brookdale 2 (M. C. Z. No. 4396-7); Santa Cruz 1 (A. N. S.); Carmel 11 (Field No. 2862-72) Monterey 2 (U. S. N. M. No. 8001, M. C. Z. No. 2102); Pacific Grove 18 (M. C. Z. No. 4373-90); Monterey Co. 15 (U. S. N. M. No. 57341-55); Fillmore 8 (M. C. Z. No. 4518-22); Santa Barbara 1 (A. N. S.); Fresno 2 (U. S. N. M. No. 11801, 61263); Fort Tejon, Kern Co. 2 (A. N. S. No. 481-2 TYPES *nigriventris*); Claremont 2 (M. C. Z. No. 4523-4); Los Angeles Co. 10 (Field No. 2807); Cahto 1 (U. S. N. M. No. 46148); Sierra Nevada Mts. 2 (U. S. N. M. No. 13963); no locality 18 (M. C. Z. No. 1196, 1827, 2109, 4295-7, U. S. N. M. No. 4009, 6890, 16274-9).

It has also been recorded from the following additional localities: Oregon: Gold Beach and Harbor, Curry County (Van Denburgh in litt.). California: Crescent City, Carlotta, Livermore, Angel Island, Freestone (Storer 1925); Morago Valley, 2 miles southwest of Napa (Camp 1915); Ukiah, 3 miles south of Nelson (Grinnell and Camp 1917); Snelling (Grinnell and Storer 1924); Santa Monica Mts. (Rüthling 1915); Bailey Cañon near Sierra Madre (Camp 1915); mountains north of Claremont (Grinnell and Camp 1917); San Gabriel Mts. (Storer 1925).

BATRACHOSEPS ATTENUATUS CAUDATUS (COPE)

1889 *Batrachoseps caudatus* Cope, Bull. U. S. Nat. Mus. 34, p. 126, f. 27; Stejneger and Barbour 1917, Check List, p. 13; 1923, id. (2), p. 9.

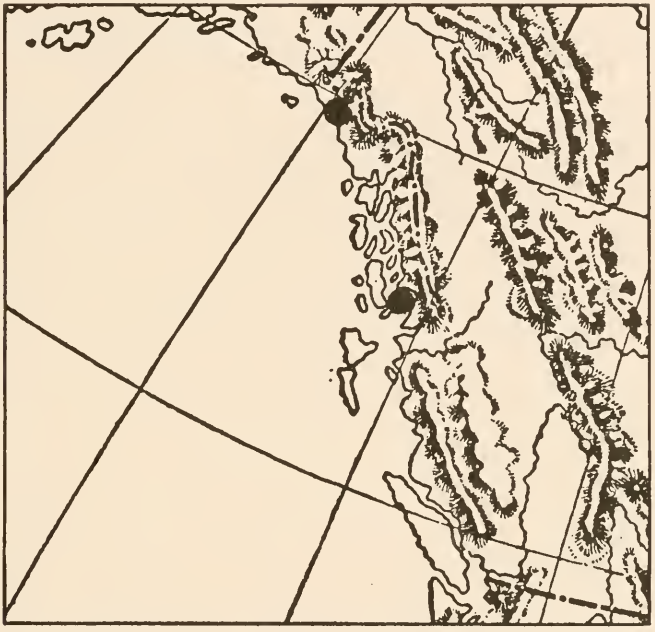
Type: U. S. N. M. No. 13561, adult female.

Type locality: Hassler Harbor, Alaska. (Probably on Anette Island, southeast Alaska, fide Stejneger and Barbour 1917).

Range: Known only from type locality and from Yukatat Bay, Alaska.

Diagnosis: Like *attenuatus,* but much darker, and with a longer tail.

Description: U. S. N. M. No. 13561, type, adult female, Hassler Harbor, Alaska; 21 costal grooves; 14 costal folds between appressed toes; head width 9½ in length from snout to vent; head length 5 in length of body; head oval; eye as long as its distance from tip of snout; outline of upper jaw concave as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down be-



30. Southern Alaska, showing localities for Batrachoseps attenuatus caudatus.

hind angle of jaw; limbs weak; fingers 3, 2, 4, 1 in order of length, 1 completely connected by web to 2; toes 3, 2, 4, 1 in order of length, 2 and 3 united to last joint, 3 and 4 united to next to last joint, 1 completely in web; tail twice as long as head and body, terete; no anal papillae; vomerine teeth 7 in series, beginning behind inner edge of nares, running in and back, separated from fellow by ⅔ length of series, and from parasphenoids by length of series; latter in two

patches beginning opposite first quarter of eyesocket; dark brown above and below, throat lighter, traces of a dark lateral stripe; total length 165; head 9, body 46, tail 110.

Remarks: The type is the only specimen in good shape and with authentic provenance. U. S. N. M. No. 17260 and 20489 are recorded as from Yukatat Bay with a query. These two specimens are in very poor condition and cannot be accurately determined.

The geographical gap between this and *attenuatus* is considerable but the relationship is very close. It differs, as do most of the peripheral races, in having a series of vomerine teeth rather than a patch, the tail is longer, and there is a decided difference in color.

Specimens seen 3, as follows:

Alaska: Yukatat Bay(?) 2 (U. S. N. M. No. 17260, 20489); Hassler Harbor (on Anette I.) 1 (U. S. N. M. No. 13561 TYPE).

BATRACHOSEPS ATTENUATUS MAJOR (CAMP)

1883 *Batrachoseps attenuatus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 28.

1915 *Batrachoseps major* Camp, U. California Publ. Zoöl. 12, 12, p. 327; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 26; Grinnell and Camp 1917, U. California Publ. Zoöl. 17, 10, p. 136; Shufeldt 1917, Aquatic Life, Sept., ff. 9-10; Stejneger and Barbour 1917, Check List, p. 14; Noble 1921, Bull. Amer. Mus. Nat. Hist. 44, p. 5 (skull); Stejneger and Barbour 1923, id. (2), p. 9; Emmel 1924, Amer. Journ. Anat. 33, p. 253 (erythrocytes); Storer 1925, U. California Publ. Zoöl. 27, p. 99.

Type: Mus. Vert. Zoöl. No. 611, collected by C. L. Camp, March 14, 1909.

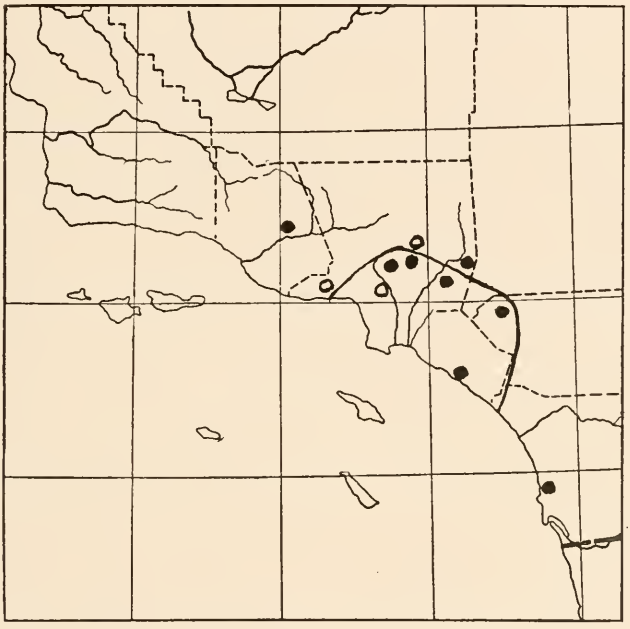
Type locality: Sierra Madre (the town), 1,000 feet altitude, Los Angeles County, California.

Range: Los Angeles, Riverside, and Orange Counties, California.

Diagnosis: A *Batrachoseps* with darker dorsal surface and lighter sides; 18 to 20 costal grooves; hind leg extending forward over 4 costal folds; vomerine teeth in irregular patch; first finger and toe normal; size large.

Description: Mus. Vert. Zoöl. No. 956, adult female, Pasadena, Cal.; 20 costal grooves; 11 costal folds between appressed toes; head width 8 in length from snout to vent; head length 4⅕ in length of body; head oval; eye as long as its distance from tip of snout; outline of upper jaw convex as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove

from eye to gular fold; limbs weak; fingers 3, 2, 4, 1 in order of length, 1 fused to hand; toes 3, 2, 4, 1 in order of length; tail longer than head and body, terete; anal lips smooth; vomerine series an irregular patch beginning behind inner border of nares, running in and a little back; separated from its fellow by width of nares and from parasphenoids by same distance; latter in two patches, beginning opposite middle of eyesocket; dark gray above, light gray on sides and below; total length 147, head 11.5, body 48.5, tail 87.



31. Southern California, showing localities for Batrachoseps attenuatus major (outlined), and nearest localities for B. a. attenuatus and for B. a. leucopus.

Variation: A male, Mus. Vert. Zoöl. No. 4576, same data, differs in having 19 costal grooves; 10 costal folds between appressed toes; head width 7 in length from snout to vent; head length 4 in length of body; vent lined with papillae; vomerine patches separated from each other by half width of nares and from parasphenoids by three times that distance; total length 123, head 10.5, body 41.5, tail 71.

A young specimen, Mus. Vert. Zoöl. No. 4577, Sierra Madre, Cal.;

has 19 costal grooves; 8 costal folds between appressed toes; head width 6 in length from snout to vent; head length 3⅓ in length of body; tail shorter than head and body; total length 49, head 6, body 20, tail 23.

Camp (1915) gives the costal fold counts for 25 specimens. Using the costal groove count and adding one (for there is always one more groove than the number of folds), his counts are: 18 in four, 19 in seventeen, and 20 in three. He says that in one specimen the fourth finger of the left hand is absent. His largest specimen measured 162, tail 91.5.

Habits: "This large, light-colored *Batrachoseps* has been taken on South Euclid Avenue beneath boards in a yard, and also in a cellar, in Pasadena, California. The type was found in the neighboring town of Sierra Madre under a broken piece of cement sidewalk, and others taken in the same vicinity were captured in piles of damp lumber and in post holes. Two were taken in August, 1905, several feet beneath the surface of the ground in loose gravel in a ravine bottom. The localities of capture lie in the upper edge of the Lower Sonoran life-zone (mesa oak association) and below the range of *Batrachoseps attenuatus*." "Entirely terrestrial . . . estivate during the drier months, being then seldom found above ground."

Remarks: This form seems fairly distinct from *attenuatus* where their ranges meet. It is very close to *catalinae* and to *leucopus*, and probably intergrades with the latter. It is larger and paler than *attenuatus*, but shares in its peculiar, patch-like, specialization of the vomerines.

Specimens seen 36, as follows:

California: Los Angeles Co.: Covina 3 (U. S. N. M. No. 62541-3); Pasadena 16 (M. V. Z. No. 954-6, 4568, 4576, 4578-86, U. S. N. M. No. 69851, A. N. S.); Sierra Madre 14 (M. C. Z. No. 8165, U. S. N. M. No. 59397-400, M. V. Z. No. 4566-7, 4569-75, 4577); Orange Co.: Laguna Beach 2 (U. S. N. M. No. 54396-7); Riverside Co.: Riverside 1 (M. V. Z. No. 6736). It has been recorded from Los Angeles (Cope 1883).

BATRACHOSEPS ATTENUATUS PACIFICUS (COPE)

1865 *Hemidactylium pacificum* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 195.

1869 *Batrachoseps pacificus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 98; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 59; Cope 1889, Bull. U. S.

Nat. Mus. 34, p. 129; Van Denburgh 1905, Proc. California Acad. Sci. (3), 4, p. 7; Van Denburgh and Slevin 1914, id. (4), 4, p. 134; Grinnell and Camp 1917, U. California, Publ. Zoöl. 17, p. 136; Stejneger and Barbour 1917, Check List, p. 13; Dunn 1918, Bull. Mus. Comp. Zoöl. 62, p. 458; Stejneger and Barbour 1923, Check List (2), p. 9; Emmel 1924, Amer. Journ. Anat. 33, p. 253 (erythrocytes); Storer 1925, U. California Publ. Zoöl. 27, p. 101.

Type: U. S. N. M. No. 6733.

Type locality: Santa Barbara, Cal. (in errore, vid. Van Denburgh 1905).

Range: San Miguel, Santa Rosa, and Santa Cruz Islands.

Diagnosis: A large *Batrachoseps* with hind leg extending over 6 costal folds; short tail; light sides; and vomerine teeth in series.

Description: U. S. N. M. No. 57388, adult male, San Miguel I., Cal.; 17-18 costal grooves; hind leg covering six costal folds; head length 4 in length of body; head oval; outline of upper jaw convex as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; limbs weak; fingers 4, 3, 2, 1 in order of length, 1 not free; toes 4, 3, 2, 1 in order of length, 1 not free; tail shorter than body; terete; vent lined with papillae; vomerine teeth 8 in series beginning at inner edge of nares, running in and back, separated from its fellow by twice width of nares, and from parasphenoids by width of nares; latter in two patches, beginning at middle of eyesocket; brown, lighter below, a dark line along sides; total length 82, head 10, body 39, tail 33.

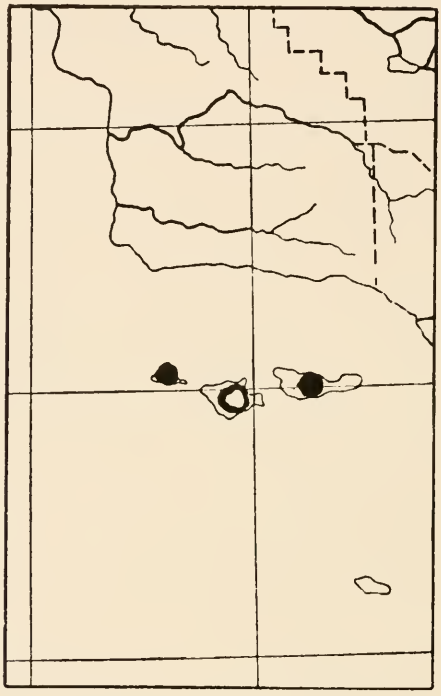
Variation: All the San Miguel specimens I have seen are in bad condition, so that their characters are difficult to make out. U. S. N. M. No. 46017 has the vomerine series separated by the width of the nares, and twice that distance separates the vomerines from the parasphenoids. U. S. N. M. No. 46018 shares these characters and also has the parasphenoids in a single patch. I have seen no specimens from Santa Rosa. From Santa Cruz I have seen 44, and these are intermediate between the San Miguel specimens and *attenuatus*.

Thus 21 specimens had a light dorsal band, 23 were as described for San Miguel. Van Denburgh and Slevin (1914) say that one specimen from San Miguel showed this band but that they had never seen it on any other specimen from any of the islands.

Out of 41 specimens from Santa Cruz 14 had 18 costal grooves, 22 had 19, and 5 had 20. Van Denburgh (1905) and Van Denburgh and

Slevin (1914) give for San Miguel 6 with 16 costal grooves, 40 with 17, and 6 with 18; for Santa Rosa 8 with 17; and for Santa Cruz 5 with 18.

Out of 44 specimens from Santa Cruz 39 had the hind leg reaching over 6 costal folds, 1 over 5, and 4 over 4.



32. Islands off California, showing localities for Batrachoseps attenuatus pacificus.

Habits: Van Denburgh and Slevin (1914) say for San Miguel "under a piece of fallen fence post in a little gully"; and for Santa Cruz "under old bark and from rotten logs in the vicinity of Pelican Bay."

Remarks: In the outermost island of the group, San Miguel, this form is very distinct but in the innermost, Santa Cruz, while the ma-

jority of specimens are distinct in the possession of longer legs, the costal grooves are those of the form of the opposite mainland, and in half of them the color is also similar. This seems a plain case for trinomials, which while logically incorrect for insular forms, are practically correct when there is anatomical overlapping.

The specimens from Palm Spring may be wrongly labeled. They are in bad shape and not distinguished from San Miguel *pacificus*. It is possible, however, that they may be representatives of a San Bernardino mountain race, correctly labeled as to locality, and that better preserved specimens might have shown differentiating characters.

Specimens seen 52, as follows:

California: Santa Barbara 1 (U. S. N. M. No. 6733 TYPE, locality erroneous); Santa Cruz I. 44 (M. C. Z. No. 3169-94, 3196, 3349-52, 4690-6, 5890-5); San Miguel I. 3 (U. S. N. M. No. 46017-8, 57388); Palm Spring(?) 4 (U. S. N. M. No. 31638-41).

It has also been recorded from Santa Rosa I. (Van Denburgh 1905).

BATRACHOSEPS ATTENUATUS CATALINAE (DUNN)

1905 *Batrachoseps attenuatus* Van Denburgh, Proc. Cal. Acad. Sci. (3), 4, p. 16; Van Denburgh and Slevin 1914, id. (4), 4, p. 137.

1922 *Batrachoseps catalinae* Dunn, Copeia 109, p. 62; Stejneger and Barbour 1923, Check List (2), p. 8.

Type: U. S. N. M. No. 57335, adult female.

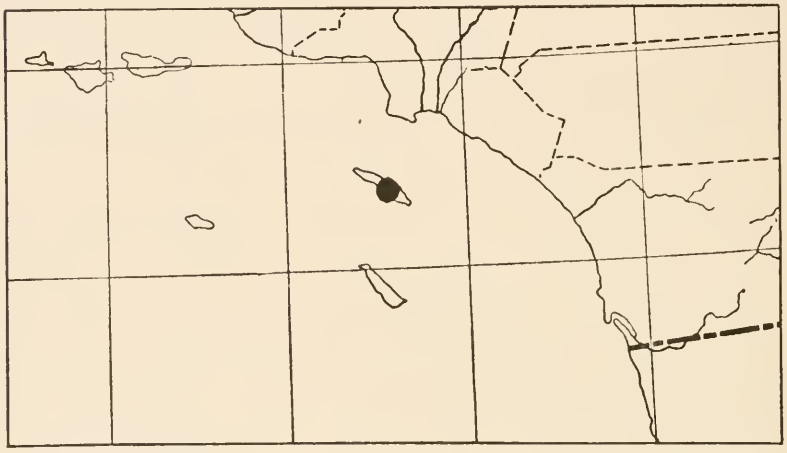
Type locality: Santa Catalina Island, California.

Range: Same.

Diagnosis: A *Batrachoseps* with dark dorsal surface and light sides; 19-21 costal grooves; hind leg extending over 4 costal folds; vomerine teeth in irregular patch; first finger and first toe very reduced.

Description: U. S. N. M. No. 57335, TYPE, adult female; Santa Catalina Island; 21 costal grooves; 12 costal folds between appressed toes; head oval; head width 7¼ in length from snout to vent; head length 4⅓ in length of body; eye longer than its distance from tip of snout; outline of upper jaw concave as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; limbs weak; fingers 3, 2, 4, 1 in order of length, 1 fused to 2, scarcely distinguishable; toes 3, 2, 4, 1 in

order of length, 1 fused to 2, scarcely distinguishable; tail longer than head and body, terete; vomerine teeth in two patches, beginning behind inner border of nares, extending in and back, separated from fellow by width of nares, and from parasphenoids by twice that distance; latter in two incompletely separated patches, beginning opposite middle of eyesocket; dark purplish above, fading into dull brownish below, no distinct line of demarcation; total length 121, head 10, body 43, tail 68.



33. Islands off California, showing locality for Batrachoseps attenuatus catalinae.

Variation: Four specimens show no important variations. U. S. N. M. No. 57334, 57336, and 38362, the vomerine series are separated from the parasphenoids by a greater distance than in the type; namely by the length of the vomerine patch. Also in these three specimens the parasphenoids are in two quite separate patches.

Measurements of the series (all are in the U. S. Nat. Mus. and are from Santa Catalina I.):

57334	97	9	38	50	♀
57335	121	10	43	68	♀
57336	80	7.5	28.5	44	yg.
38361	103	8	35	60	yg.
38362	96	7.5	33.5	55	yg.

Remarks: This form is quite close to *major,* the coloration is very

similar, but the small size of the animal, the reduced first digits, and the larger number of costal grooves indicates a recognizable form.

Van Denburgh (1905) says: "A single specimen collected at Avalon, Santa Catalina Island, by Mr. A. M. Drake (Cal. Acad. Sci. No. 3726) seems indistinguishable from the mainland species. It has nineteen costal grooves, slender limbs, and narrow head. The coloration is uniform slaty brown above, paler below. Three specimens secured on this island by Mr. Fuchs differ from this one only in the slightly paler coloration."

It is certainly different in appearance from *attenuatus* which has a distinct pale dorsal stripe.

Specimens seen 5, as follows:

California: Santa Catalina Island 5 (U. S. N. M. No. 57334-6, 38361-2).

BATRACHOSEPS ATTENUATUS LEUCOPUS (DUNN)

1880 *Batrachoseps attenuatus* Lockington, Amer. Nat. 14, p. 295; Van Denburgh 1895, Proc. California Acad. Sci. (2), 5, p. 560; Gadow 1905, Proc. Zoöl. Soc. London, p. 203; Hilton 1909, Amer. Nat. 43, p. 54; Van Denburgh and Slevin 1914, Proc. California Acad. Sci. (4), 4, p. 139.

1922 *Batrachoseps leucopus* Dunn, Copeia 109, p. 60; Stejneger and Barbour 1923, Check List (2), p. 9.

Type: U. S. Nat. Mus. No. 64319, adult female, collected by A. W. Armstrong, August 4, 1921.

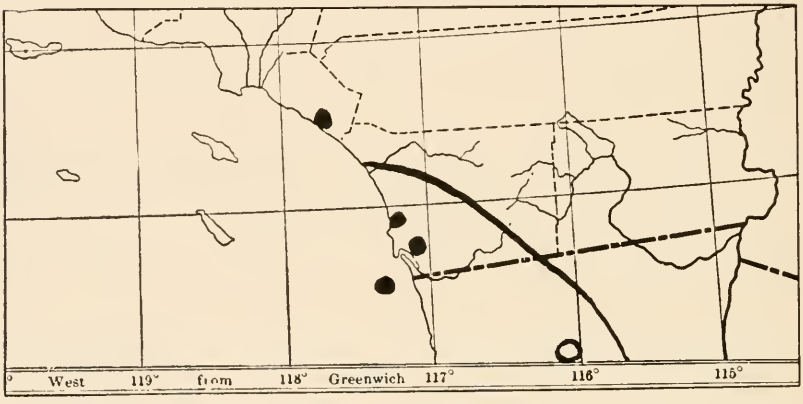
Type locality: Los Coronados, North Island, Baja California, Mexico.

Range: San Diego Co., California, Los Coronados Islands, (?) Baja California, (?) Mexico.

Diagnosis: A *Batrachoseps* with light sides and darker dorsal surface, 18-20 costal grooves, hind leg extending forward over 4 costal folds, vomerine teeth in series of 8; first digits normal.

Description: U. S. N. M. No. 64319, adult female, Los Coronados, North Island, Baja California, Mexico; 20 costal grooves; 12 costal folds between appressed toes; head oval; head width 7⅔ in length from snout to vent; head length 5⅓ in length of body; eye longer than its distance from tip of snout; outline of upper jaw convex as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold;

limbs weak; fingers 3, 2, 4, 1 in order of length, 1 not free from 2; toes 3, 2, 4, 1 in order of length, 1 not free from 2; tail longer than head and body; cylindrical in cross-section, scarcely tapering, ending in a blunt point; lips of vent smooth; vomerine teeth 8 in series, beginning behind inner edge of nares, running nearly straight back and slightly in, separated from fellow by width of nares and from parasphenoids by the same distance; latter in a single patch, divided behind, beginning opposite middle of eyesocket; blackish above, light whitish gray below postocular groove and insertions of legs; tail dark on dorsal surface, sides and below light; total length 101, head 9, body 38, tail 54.



34. Southern California, showing localities for Batrachoseps attenuatus leucopus (outlined), and nearest localities for B. a. major.

Variation: Two other specimens from the same island, A. M. N. H. No. 16107-8, both females, differ somewhat from the type. No. 16107 has 19 costal grooves, the vomerine series are separated by ½ width of nares and from parasphenoids by four times that distance; parasphenoids nearly completely divided; dorsum rather lighter than the type, a darker dorsolateral line; total length 76, head 8, body 33, tail 35.

Specimens from San Diego County, while approaching *major* seem best considered as belonging to this race. They have 19-20 costal grooves and are smaller than *major,* have the vomerine teeth in a

series rather than in a patch, and the coloration is neither the very light *major* type, nor that of *attenuatus* with dark sides and light dorsum.

Most of them resemble A. M. N. H. No. 16107 in color, as does one from La Jolla, M. C. Z. No. 7828, which is dark above, lighter on sides and below, a dark line on sides of dorsum.

Field Mus. No. 2906, from San Diego, has 18 costal grooves. Van Denburgh and Slevin (1914) mention 60 specimens, 55 of which were collected on East Coronado. They state that out of 38 specimens 36 had 18 costal grooves and 2 had 19.

Remarks: The extreme southern form of *Batrachoseps* merits racial recognition. Grinnell and Camp (1917) in discussing *attenuatus* and *major* had no records for the range of *leucopus,* although *attenuatus* had been recorded from Coronados, San Diego, the San Pedro Martirs, La Paz and Colima. Whether the three latter localities are inhabited by *leucopus* or not lack of specimens leaves unanswerable. However, it is appropriate to place the most southern records of the genus under the most southern known form.

Specimens seen 18, as follows:

California: San Diego Co.: La Jolla 1 (M. C. Z. No. 7828); Old Mission 1 (U. S. N. M. No. 21332); San Diego 13 (Field No. 2906-7, U. S. N. M. No. 13895, 16286, 49998, 53554, 53548, 53546, 59466, 61748-51).

Baja California: Los Coronados, North Island 3 (A. M. N. H. No. 16107-8, U. S. N. M. No. 64319 TYPE).

It has also been recorded from Nevada de Colima, 7,000 feet altitude (Gadow 1905); La Paz, Baja California (Lockington 1880); the San Pedro Martir Mts., Baja California (Van Denburgh 1895); East Coronado Island (Van Denburgh and Slevin 1914).

STEREOCHILUS COPE

1869 *Stereochilus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 100. (Type *marginatum*).

Diagnosis: Tongue attached in front; one premaxilla, nasal spines not fused, a fontanelle; maxilla normal; prefrontals present, not bordering nares; internal naris a slit in prevomer; vomerine and parasphenoid series continuous; condyles sessile; atlas normal; eyes functional; gills of larva with long rami; no sexual dimorphism; tail not constricted at base; toes 4-5, free; no palmar tubercles; terminal phalanges T-shaped. One species.

Range: Same as that of type species.

STEREOCHILUS MARGINATUM (HALLOWELL)

1856 *Pseudotriton marginatus* Hallowell, Proc. Acad. Nat. Sci. Philadelphia, p. 130.

1869 *Stereochilus marginatum* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 101.

1870 *Spelerpes marginatus* Strauch, Mem. Acad. Sci. St. Petersbourg (7), 16, 4, p. 83.

1884 *Geotriton marginatus* Garman, Bull. Essex Inst., 16, p. 40.

1889 *Stereochilus marginatus* Cope, Bull. U. S. Nat. Mus. 34, p. 152, f. 36; Kingsbury and Reed 1908, Journ. Morph. 20, p. 576 (otic apparatus); Brimley 1909, Proc. Biol. Soc. Washington 22, p. 131 (habits); Dunn 1918, Bull. Mus. Comp. Zoöl. 42, p. 464; 1920, Copeia 77, p. 8; Myers 1924, Copeia 131, p. 59; Brimley 1925, Copeia 139, p. 14; Noble 1925, Journ. Morph. 40, p. 372, f. 17 (skin).

Type: Acad. Nat. Sci. No. 514, collected by Major Le Conte.

Type locality: Liberty Co., Georgia.

Range: From Liberty Co., Ga., to Dismal Swamp, Va., in the Coastal Plain.

Diagnosis: A salamander with flattened, finned tail; small head with large pores above and on sides; dull brown above, lighter below; a light streak between fore and hind legs; tongue attached in front. Reaches 95 mm.

Description: M. C. Z. No. 2541, adult female; Lake Ellis, N. C. Costal grooves 19; 7 costal folds between appressed toes; head width 7½ in length from tip of snout to vent; head length 5 in length of body; head oval from above; sides of head covered with pores larger than the nostril which is very indistinct; naso-labial groove very indistinct; eye shorter than its distance from tip of snout; snout not swollen; no canthus rostralis; edge of upper jaw straight as viewed

from the side, turned down at angle which is back of hind angle of eye; lower eyelid fitting under upper in front; upper and lower both fitting under a fold of skin behind; a groove from hind angle of eye back to meet gular fold on side of neck; limbs weak; fingers long, 3, 2, 4, 1 in order of length; toes long, 4, 3, 2, 5, 1 in order of length; tail shorter than body, flattened, keeled, and finned dorsally throughout and keeled ventrally in distal half; lips of anus smooth; vomerine and parasphenoid series connected, beginning behind outside edge of nares, passing straight inwards until they nearly meet and then making a right angle and passing backwards, very closely approximated to middle of eyesockets where they diverge; brownish above, somewhat mottled with linear streaks of lighter; this forms, on the sides, light lines, three of which can be made out; the lowest is the most definite and runs between the insertions of the limbs and is bordered below by a dark line; head with a blackish line from nostril through eye along lateral neck groove to gular fold, a rather light patch above this and behind eye; an indefinite light line from eye to angle of jaw; belly cream color, much dotted with irregular brownish spots; limbs dark above, lighter below; total length 71 mm., head 8, body 41, tail 22.

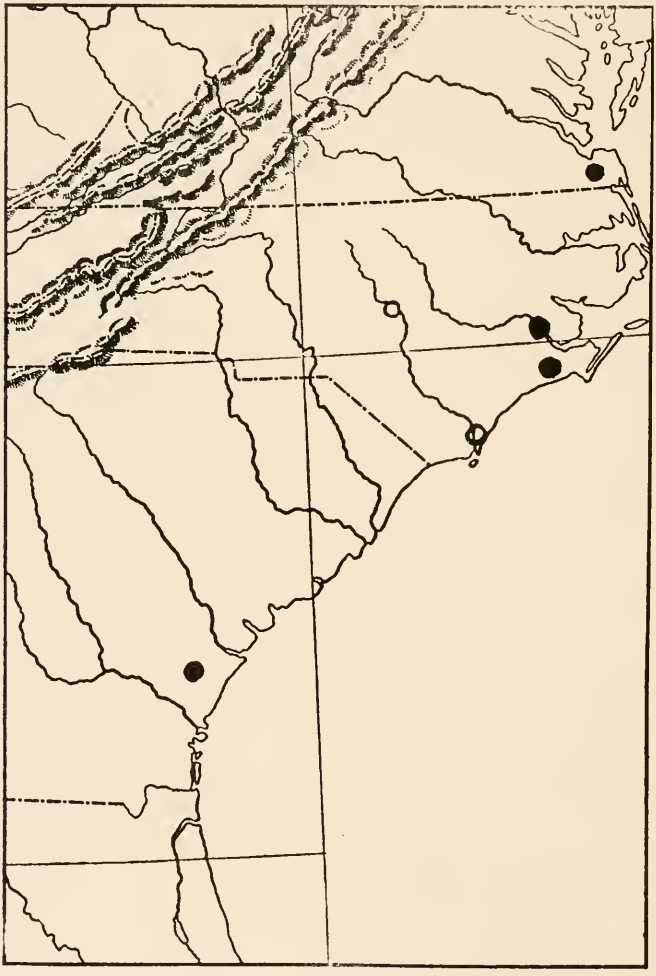
Variation: A male U. S. N. M. No. 36635, same locality, has 18 costal grooves; 8 costal folds between the appressed toes; head width 8 in length from tip of snout to vent; head length 4½ in length of body; anal lips lined with papillae; total length 79, head 8, body 36, tail 35. A larva, U. S. N. M. No. 36270, same locality, shows striking resemblance to the adult in coloration, the same irregular streaking on the sides being present in both; appressed toes separated by 6 costal folds and there are 19 costal grooves; total length 41, head 4.5, body 19.5, tail 17.

Largest male seen	81	8	38	35	U. S. N. M. 58118	Lake Ellis, N. C.
Largest female seen	94	9	42	43	U. S. N. M. 36632	Lake Ellis, N. C.
Smallest adult seen	63	7.5	31.5	25	Smith College	Lake Ellis, N. C.
Larva	41	4.5	19.5	17	U. S. N. M. 36270	Lake Ellis, N. C.

Brimley says adults reach 95 mm. and larvae reach 87 mm.

Habits: Brimley (1909) says of it at Lake Ellis, N. C., "apparently an aquatic mud-burrower," and he then adds the following habitat notes "under a log . . . in woods," "obtained by merely scraping away the covering of semi-decayed vegetable matter around the edges

of the pools," "in small cells just below the surface layer of vegetable matter." "The canal was nearly dry, there being no stream running through it, and only a few small pools of water standing in its bed." "I set to work to drag out the dead leaves and vegetable mud and throw it up on the sloping banks of the canal. On doing this the



35. South Atlantic Coast, showing localities for Stereochilus marginatum.

sirens or salamanders would crawl from under the trash and run swiftly towards the water." Others were taken by "dipping out pools" and "two were dug up out of marsh . . . while looking for fish bait."

Remarks: This species seems very isolated and it is scarcely profitable to speculate on its relationship. Yet in many points it reminds one of *Pseudotriton*, though, of course, neither could conceivably be ancestral to the other, while it has points of similarity with *Typhlotriton* as well. But certainly none of the features of the animal call to mind any other genus of *Plethodontidae*. At present it is impossible to derive *Stereochilus* from any known genus of the family, in the way one can derive *Aneides* from *Plethodon* or *Leurognathus* from *Desmognathus*. Nor can it be immediately derived from a common stock along with another genus as is the case of *Eurycea* and *Oedipus*. It simply shows general affinities to the more primitive members of the *Eurycea* group.

Described in 1856 and made the type of a separate genus in 1869, it was only known from the type locality until Brimley's rediscovery in 1909.

Specimens seen 16, as follows:

Georgia: Riceboro 1 (A. N. S. No. 514 Type).
North Carolina: Lake Ellis 13 (Smith, M. C. Z. No. 2541, U. S. N. M. No. 36269-70, 36632-5, 58718-21); New Berne 1 (M. C. Z. No. 4742).
Virginia: Dismal Swamp 1 (U. S. N. M. No. 45912).

It has also been recorded from Wilmington, N. C. (Myers 1924); and Bunlevel, N. C. (Brimley 1925).

TYPHLOTRITON STEJNEGER

1892 *Typhlotriton* Stejneger, Proc. U. S. Nat. Mus. 15, p. 115 (type *spelaeus*).

Diagnosis: Tongue attached in front; one premaxilla, nasal spines fused; a fontanelle; maxilla normal; prefrontals present, not bordering nares; internal naris a notch in prevomer; vomerine and parasphenoid series usually continuous; condyles sessile; atlas normal; eyes scarcely functional; three epibranchials; gills of larvae with long rami; male with swollen snout and short blunt cirri; tail not constricted at base; toes 4-5, free; no palmar tubercles; terminal phalanges T-shaped; one species.

Range: Same as that of type species.

TYPHLOTRITON SPELAEUS STEJNEGER

1892 *Typhlotriton spelaeus* Stejneger, loc. cit., p. 115; Cope 1894, Proc. Acad. Nat. Sci. Philadelphia, p. 384; Eigenmann and Denny 1899, Proc. Indiana Acad. Sci., p. 252 (eyes); 1900, Biol. Bull. 3, p. 33 (eyes); Eigenmann 1900, Science (N. S.) 11, p. 493 (eyes); 1900, Popular Science Monthly 56, p. 474, f. 2; 1900, Proc. Indiana Acad. Sci., p. 32 (eyes); Moore 1900, Proc. Acad. Nat. Sci. Philadelphia, p. 620 (vertebrae); Hurter 1903, Trans. Acad. Sci. St. Louis 13, 3, p. 80, pl. 18, f. 7; Eigenmann 1909, Carnegie Inst., Publ. 104, p. 28, pl. 1, ff. D, Dd (eyes, habits); Hilton 1909, Biol. Bull. 16, p. 167 (branchial arches); Alt 1910, Trans. Acad. Sci. St. Louis 19, p. 83 (eyes); Hurter 1911, Trans. Acad. Sci. St. Louis 20, p. 91, pl. 18, f. 7; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 23; Stejneger and Barbour 1917, Check List, p. 23; Dunn 1918, Bull. Mus. Comp. Zoöl. 42, p. 464; Stejneger and Barbour 1923, Check List (2), p. 20.

Type: U. S. Nat. Mus. No. 17903, collected by F. A. Sampson.

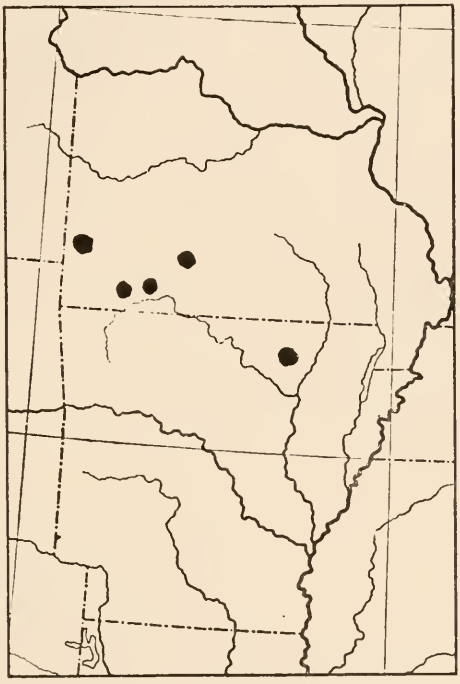
Type locality: Rockhouse Cave, Barry Co., Missouri.

Range: Ozark Plateau in Missouri and Arkansas.

Diagnosis: A blind, white, cave salamander, with normal legs, which completes the metamorphosis.

Description: M. C. Z. No. 2781, adult male; Marble Cave, Stone Co., Mo.; 16 costal grooves; 4 costal folds between appressed toes; head width 6 in length from tip of snout to vent; head length 3½ in length of body; head polygonal with angles at the nostrils; eye minute, hidden under the closed eyelids; groove of eyelid shorter than its distance from nostril; snout swollen; a swelling of upper lip below nostril, which forms a short blunt cirrus whose tip is free; outline

of upper jaw straight as viewed from side; angle of jaw back of eye; a groove from eye to gular fold; a groove from this down behind angle of jaw; a groove from eye to angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 2, 5, 1 in order of length; tail slightly shorter than head and body, ovoid in section, a thick dorsal keel throughout; anal lips lined with papillae; vomerine series



36. Missouri and Arkansas, showing localities for Typhlotriton spelaeus.

continuous with parasphenoids, beginning behind center of nares, passing in and forwards to level of anterior third of nares, forming an acute angle and passing backwards paralleled by its fellow series, separated from it by the width of the naris; no markings; above dark so thickly set with tiny white circular dots that the general effect is grayish white; beneath white; upper surface of limbs and tail and

head similar to upper surface of body; total length 115, head 13, body 46, tail 56.

Variations: A female, M. C. Z. 2878, same locality, differs in less swollen snout; no cirri; 3 costal folds between appressed toes; no papillae on anal lips; tooth rows on parasphenoid further apart, separated by length of short side of tooth row angle; total length 111 mm., head 13, body 43, tail 55. A larva, M. C. Z. 2876, same locality, has 4 costal folds between the appressed toes; more heavily pigmented than the adult, especially at each side of the mid-dorsal line of the tail; it shows the upper row of larval areas, a row of small light dots, about ⅔ as many as the costal folds, extending on to the tail; there is a dark line from eye to nostril; total length 93, head 9, body 38, tail 46. Another larva, M. C. Z. 4608, Wilson's Cave, Mo., has 6 costal folds between the appressed toes and shows marked pigmentation, the upper row of larval areas being present, the middle row is represented by three irregular series of small light streaks, and the lower row may be traced; brown dorsally, lead-colored laterally; tail lead color flecked with white; total length 66, head 7.5, body 28.5, tail 30.

Two out of six adults at hand as I write show the vomerine series separated from the parasphenoids. In one, M. C. Z. 3141, male, Stone Co., Mo., the inner arm of the vomerine angle is shorter, 7 teeth against 10 in the outer, and the gap is equal to the short arm of the angle.

Largest male	128	14	48	66	U. S. N. M. 57328	Stone Co., Mo.
Largest female	111	13	43	55	M. C. Z. 2876	Marble Cave, Stone Co., Mo.
Largest larva	93	9	38	46	M. C. Z. 2876	Marble Cave, Stone Co., Mo.
Smallest adult	74	9	30	35	M. C. Z. 2781	Marble Cave, Stone Co., Mo.
Smallest larva	24	3	12	9	M. C. Z. 2554	Marble Cave, Stone Co., Mo.

Eigenmann (1909) gives 134 mm. for an adult.

Habits: Hurter (1911) and Eigenmann (1909) give the best accounts of the habits. In brief, they are found in caves, larvae "under loose stones and gravel in the riverlet at the mouth" of Rockhouse Cave and "in a small spring" near Marble Cave, and adults nearly 600 feet inside of Rockhouse Cave and over half a mile inside of Marble Cave. Larvae have also been found well inside in Marble Cave. "In the caves both larvae and adults are found under stones, the old ones in and out of the water. Occasionally one is seen lying on the bottom of a pool" (Eigenmann). Hurter collected them "partly from the sides of the walls, where they were clinging and from the water."

According to Eigenmann the larvae are stereotropic rather than negatively heliotropic. (See *Eurycea bislineata bislineata*) and "it detects its food by the sense of touch without the use of its eyes." Though he does not definitely so state, I gather that the larvae eat worms.

Remarks: There are quite a number of characters which ally this salamander to the free-tongued species and especially suggest *Pseudotriton.* These are the 3 epibranchials, the usually connected vomerine and parasphenoid tooth rows, the large larvae with pigmented gills, and the premaxilla with its small fontanelle and fused nasal processes. The prefrontal is somewhat between that of *Eurycea* and that of *Pseudotriton.* The sexual dimorphism is further along in its development than it is in *Pseudotriton.* The drawback, and the only drawback, to alliance with the *Eurycea* group is the attached tongue. But the tongue of *Typhlotriton* is more nearly free than is that of *Stereochilus,* which in turn is more free than is that of *Desmognathus* or *Plethodon.* In the last three genera the tongue stalk is attached near the posterior edge of the circular tongue, in front of this the tongue is attached by the median line to the floor of the mouth and in *Desmognathus* and in *Plethodon* by nearly the whole front edge. In *Typhlotriton* the stalk is attached to the middle of the circular tongue and there is anterior to the stalk a very frail attachment of the median line of the tongue to the floor of the mouth.

To sum up: The tongue of *Typhlotriton* approaches nearer to that of the *Eurycea* group than does that of any other species with attached tongue. The larvae, the dentition and the skull show some similarity with those of *Pseudotriton.* There are no characters which suggest any other genus or group of genera with the possible exception of *Typhlomolge,* to be dealt with presently. It seems to me to be a survival, modified for cave life, of a form certainly very close to the ancestors of the *Eurycea* group if not of the same stock. The characters which led Stejneger (1892), and Cope (1894), to consider it allied to *Desmognathus* are wholly illusory. Moore (1900) has shown the vertebrae not to be different from those of *Pseudotriton;* while the fact of a slip of the *temporalis* muscle originating on the atlas has no significance whatever in view of the very general occurrence of this phenomenon, and in the absence of any specialization of this slip or of the atlas or of the condyles such as is found in *Desmognathus.*

The eye has been the subject of much research. Eigenmann (1909)

and Alt (1910) have given the most recent accounts. Unfortunately on page 40 of the former, under the heading, "Conclusions as to the eye of *Typhlotriton spelaeus*" what follows refers entirely to *Typhlomolge rathbuni* and the "Summary in regard to *Typhlotriton*" on page 41 contains the actual matter concerning this animal.

Specimens seen 87, as follows:

Missouri: Stone Co., Marble Cave 26 (Field Mus., A. N. S., M. C. Z. No. 2781, 2973-80, 3141; U. S. N. M. No. 37051-4, 38786-91, 57147); Reed's Spring 1 (M. C. Z. No. *3485*). Jasper Co., Wilson's Cave 25 (M. C. Z. No. *2269, 2270, 4607-8*). Wright Co., Doris Cave 1 (M. C. Z. No. *2554*). Barry Co., Rockhouse Cave 23 (U. S. N. M. No. 17903 TYPE, *17904-12, 19776-9*, 21891, 61976-83). Stone Co. and Wright Co. 9 (U. S. N. M. No. 57324-32).

Arkansas: Lawrence Co. 2 (U. S. N. M. No. *64899, 64901*).

TYPHLOMOLGE STEJNEGER

1896 *Typhlomolge* Stejneger, Proc. U. S. Nat. Mus. 18, p. 620 (type *rathbuni*).

Diagnosis: One premaxilla, nasal spines not fused; a fontanelle; condyles sessile; atlas normal; eyes functionless; 3 epibranchials; gills with long rami; breeds in larval stage, not transforming; legs very long and slim; no sexual dimorphism; tail not constricted at base; toes 4-5, free; terminal phalanges T-shaped; no palmar tubercles; one species.

Distribution: Same as that of the type species.

TYPHLOMOLGE RATHBUNI STEJNEGER

1896 *Typhlomolge rathbuni* Stejneger, loc. cit., p. 620; Blackford 1899, Nature 60, p. 389 (habits); Norman 1900, Amer. Nat., p. 179 (habits); Eigenmann 1899, Proc. Indiana Acad. Sci. 1898, p. 251 (eyes); 1900, Proc. Indiana Acad. Sci., p. 32 (eyes); 1900, Science (N. S.) 11, p. 493 (eyes); 1900, Trans. Amer. Micr. Soc., p. 49 (eyes); 1900, Pop. Sci. Monthly 56, p. 474, f. 3; Stone 1903, Proc. Acad. Nat. Sci. Philadelphia, p. 538; Emerson 1905, Proc. Boston Soc. Nat. Hist. 32, p. 43 (anatomy); Kingsbury and Reed 1908, Journ. Morph. 20, p. 586 (otic apparatus); Eigenmann 1909, Carnegie Inst. Publ. 104, pl. 2, ff. B, Bb (eyes); Stejneger and Barbour 1917, Check List, p. 6; Dunn 918, Bull. Mus. Comp. Zoöl. 42, p. 465; Uhlenhuth 1919, Copeia 69, p. 26; Reed 1920, Journ. Morph. 33, p. 354 (otic apparatus); Smith 1920, Journ. Morph. 33, p. 533 (branchial arches); Uhlenhuth 1921, Biol. Bull. 40, p. 73; 1923, Biol. Bull. 45, p. 303 (endocrine system).

Type: U. S. Nat. Mus. No. 22686.

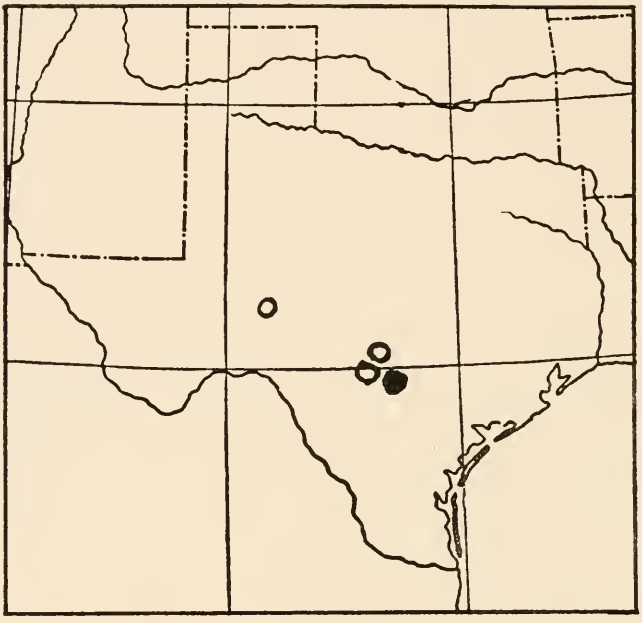
Type locality: Artesian well 188 feet deep, at U. S. Fish Commission Station, San Marcos, Hays Co., Texas.

Range: Known only from vicinity of the type locality.

Diagnosis: A blind, white, gill-bearing salamander, with very long, slim legs.

Description: Mus. Comp. Zoöl. No. 4654, adult male; Frank Johnson's well, near San Marcos, Tex.; 12 costal grooves; appressed legs overlapping, toes reaching elbow; head width 4 in length from tip of snout to vent; head length 3 8/11 in length of body; head a blunt oval; eye a tiny dot covered by uniform skin; snout very flat; labial folds of larvae well developed; gular fold on sides of neck to dorsal surface; angle of jaw well forward of eye spot; no eyelids; no grooves on head; limbs long and slim; fingers 3, 2, 4, 1 in order of length;

toes 3, 4, 2, 5, 1 in order of length; tail shorter than body, keeled and finned throughout both above and below; anal lips lined with papillae; vomero-palatine teeth in four series making a ∩, nearly meeting in mid line in front, and with a break half way down the side; nares just outside tooth row just anterior to lateral break; color dull whitish with a sort of iridescent surface; total length 85, head 11, body 41, tail 33.



37. Texas, showing localities for Typhlomolge rathbuni.

A female, M. C. Z. 4170, differs in the smooth anal lips; total length 93, head 13, body 39, tail 41.

Largest male	136	20	56	60
Largest female	110	14	46	50
Smallest	51	8.5	26	16.5

Eigenmann (1909) mentions one 30 mm. long.

Habits: Norman (1900) in a paper on the actions of captive specimens says, "Examination of a dead specimen showed chitinous remains of such crustacea as Cyclops." Uhlenhuth (1919) says, "Ob-

servations of the animal under natural as well as laboratory conditions, reveals the presence of a number of habits so far found only in the larvae of the red salamander *Eurycea rubra*" and "From the conditions found in the habitat of *Typhlomolge* it is evident that this salamander prefers water which is under high pressure." The first specimens came up from the U. S. Fish Commission Well at San Marcos, Texas, which was 188 feet deep. Uhlenhuth has taken them in Ezell's Cave, Beaver Cave, and Frank Johnson's Well, all near San Marcos. These three are supplied with water by the Purgatory Creek system. The cave which supplies the Fish Commission Well is on the low side of the Balcones fault and hence some 200 feet lower than the Purgatory Creek caves, which are on the upper side, although both are in the Edwards Limestone. He suggests a connection between the Purgatory Creek system and the Fish Commission Well. The latter contains the blind crustaceans *Palaemonetes antrorum* and *Cirolanides texensis*, known also from the Purgatory Creek water, so that three cave species are known from both horizons. The Fish Commission Well is the only one in the "sweet water horizon" which contains these creatures, and Uhlenhuth suggests that the Purgatory Creek system was the original habitat. Many details of the caves are contained in his latter paper (1921).

Eigenmann (1909) says of a specimen received in Washington on April 8, 1896, that it laid a few eggs about March 15, 1896. A female lent me by Dr Uhlenhuth, and collected in the early fall of 1916, had the spermatheca packed with spermatozoa.

The legs are futile for land locomotion and probably the animal never leaves the water. There is no thyroid gland, "a phenomenon singular in the vertebrates."

Remarks: In dealing with this animal, as with any salamander which breeds in the gill-bearing stage, it is of little avail to compare it with transformed animals in an endeavor to ascertain its true relationships. To do this would indeed be to "postulate the form which might be assumed were this permanent larva ever to transform." The proper comparison of gill-bearing form with gill-bearing form should be made, and this with little regard to whether the genitalia have or have not reached a mature state.

Among gill-bearing forms the *Sirenidae* are obviously very different from *Typhlomolge*, and need not be considered. The question

whether *Typhlomolge* resembles more *Necturus* and *Proteus* on the one hand or the larva of a member of the *Hynobiidae, Salamandridae, Pleurodelidae, Ambystomidae,* and *Plethodontidae* on the other, is the problem to be determined.

The pelvis: *Typhlomolge* has the pelvis of the *Mutabilia* (group name for the five families above together with the aberrant *Cryptobranchidae* and *Amphiumidae*) and not the pelvis of *Proteida* (group name for *Necturus* and *Proteus*). In the *Proteida* there is an anterior projection of the pubic cartilage, in the *Mutabilia* this projection is absent.

The branchial arches: *Typhlomolge* has a well developed second ceratobranchial, as have the larvae of the Mutabilian groups; in the *Proteida* this bar is degenerate. In *Typhlomolge,* as in larvae of *Pleurodelidae, Salamandridae, Plethodontidae,* and *Ambystomidae,* the second basibranchial remains fused with the first ceratobranchials until metamorphosis. This is not the case in the *Proteida,* nor in the *Hynobiidae.*

The premaxilla: This is single, a condition found elsewhere only in certain *Salamandridae, Pleurodelidae,* and *Plethodontidae.*

The otic apparatus: In *Necturus* both columella and operculum are present, fused together and free from periotic. In *Typhlomolge* both columella and operculum are present, fused together and attached by a narrow isthmus to the periotic. This last is the condition in the *Plethodontidae,* but not in the other Mutabilian families under consideration.

Lungs: The lungs are completely absent. This is the general condition in the *Plethodontidae. Necturus* and *Proteus* have well developed lungs. Occasional members of the *Hynobiidae, Pleurodelidae, Salamandridae,* and *Ambystomidae* have reduced or aborted lungs.

The spermatheca: This is a single pigmented sac-like structure. It thus differs from that of *Proteida,* in which the organ consists of numerous separate tubules. The *Hynobiidae* have no spermatheca, *Ambystomidae, Pleurodelidae,* and *Salamandridae* have numerous separate tubules, and *Plethodontidae* have a single sac-like structure.

The characters given above all serve to show the difference between the *Proteida* and *Typhlomolge* and to show the resemblance between *Typhlomolge* and a Mutabilian larva, especially a larva of the family *Plethodontidae.* Among Mutabilian larva three epi-

branchials are found in certain Plethodont forms, while larval Ambystomids, Pleurodelids, Salamandrids, and Hynobiids have four. *Typhlomolge* has three epibranchials.

There is therefore a narrowing down of complete resemblance to one group, the *Plethodontidae*. The differences between *Typhlomolge* and any known Plethodont larva are: the legs are very long and slim; the animal lacks pigment; the eyes are aborted; it has no thyroid, does not transform, and breeds in the gill-bearing state. The length of the legs, the color, and the condition of the eyes are surely of no greater than generic weight, as witness *Typhlotriton* and the worm-like "Oedipinas." There remains then as the one important difference between *Typhlomolge* and a Plethodont larva the absence of transformation in the former. Since we know of cases in the *Hynobiidae, Pleurodelidae,* and *Ambystomidae* (Boulenger, Les Batraciens, 1910, p. 54, says *Spelerpes ruber* is sometimes neotenic, but I can find no other reference) where individuals of a species may occasionally or usually breed in the gill-bearing stage, this last difference loses its weight. Every character of importance, then, shows, if anatomy shows anything, that as far as the anatomy goes *Typhlomolge* is identical with Plethodont larvae. There is no need "to postulate the form which might be assumed." The form which the animal *has* is the form of a Plethodont larva. More, it is the form of a Plethodont larva with one premaxilla, and three epibranchials, in brief the form of a larval *Typhlotriton, Pseudotriton,* or *Eurycea.* Miss Emerson (1905) compared it carefully with larvae of *Pseudotriton* and found many similarities. She did not compare it with larvae of *Typhlotriton*, but in view of the extreme similarity between the two transforming genera, the suggestion may be made that *Typhlotriton* is really the closest ally of *Typhlomolge,* and that the two cave salamanders of Missouri and of Texas have some bond in common beside their habitat. They both possess the rather unusual characters of fused premaxillae, three epibranchials, deficient pigment, and degenerate eyes.

Specimens examined 45, as follows:

Texas: San Marcos, U. S. Fish Commission Well 42 (M. C. Z. No. 2428, 4170-1, U. S. N. M. No. 22686 TYPE, 22687-90, 22692-3, 36008-11, 51305-27, 51372-3, A. N. S.; Frank Johnson's Well 3 (Uhlenhuth Coll. 1, M. C. Z. No. 4653-4).

Uhlenhuth (1921) says it has also been seen at the head of the San Marcos river near San Marcos; at Burnet Cave, Kendall Co., near Burnet; at a spring near Twin Sister Mountain, Hays Co., 2 miles from Wimberly; at a spring near Ozona [Crockett Co.], 100 [200] miles from San Marcos. These localities, especially the last, should be confirmed by specimens before being unqualifiedly accepted.

GYRINOPHILUS COPE

1869 *Gyrinophilus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 108 (type *porphyriticus*).

Diagnosis: Tongue free all round; two premaxillae, a fontanelle; a septomaxilla; maxilla normal; prefrontals present, not bordering nares; internal naris a notch in prevomer; vomerine and parasphenoid series continuous; condyles sessile; atlas normal; eyes functional; gills of larva with long rami; 3 epibranchials; no marked sexual dimorphiam; tail not constricted at base; toes 4-5, free; terminal phalanges T-shaped; no palmar tubercles; two species.

Range: Maine to Georgia and west to Ohio.

Key to adults of *Gyrinophilus:*

A. A light and a dark line from eye to nostril; color clear, with black dots. . . . . *danielsi* 266

AA. A light line from eye to nostril; color clouded, no black dots. . . . . *porphyriticus* 259

GYRINOPHILUS PORPHYRITICUS (GREEN)

1827 *Salamandra porphyritica* Green, Contr. Maclurian Lyc. 1, p. 3.

1842 *Triton porphyriticus* Holbrook, N. Amer. Herp. (2), 5, p. 83, pl. 28.

1850 *Spelerpes? porphyriticus* Gray, Cat. Batr. Grad. Brit. Mus., p. 46.

1877 *Spelerpes porphyriticus* Smith, Tailed Amph., p. 91; 1882, Rept. Amph. Ohio, p. 729; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 64; Boettger 1892, Kat. Batr. Mus. Senckenbergianum, p. 60; Wilder 1896, Anat. Anz. 12, p. 183; Howe 1904, Proc. Biol. Soc. Washington 17, p. 102; Whipple 1906, Biol. Bull. 10, p. 257 (ypsiloid).

1869 *Gyrinophilus porphyriticus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 108; Widersheim 1877, Morph. Jahrb. 3, p. 102, pl. 25, f. 99 (skull); Cope 1883, Proc. Acad. Nat. Sci. Philadelphia, p. 24 (gills); Yarrow 1883, Bull. U. S. Nat. Mus. 24, p. 158; Abbott 1885, Nat. Rambles, p. 477; Cope 1888, Journ. Morph. 2, pl. 22, f. 33 (otic apparatus); 1889, Bull. U. S. Nat. Mus. 34, p. 155, f. 37, pl. 30, f. 6, pl. 33, ff. 1-6, pl. 34, ff. 1-4, pl. 35, f. 6, pl. 40, f. 3, pl. 42, f. 1, pl. 48, f. 13; Wilder 1894, Anat. Anz. 9, p. 216 (lunglessness); Mearns 1898, Bull. Amer. Mus. Nat. Hist. 10, p. 303; Moore 1901, Proc. Acad. Nat. Sci. Philadelphia, p. 619 (vertebrae); Morse 1901, Ohio Nat. 1, p. 115; Britcher 1903, Proc. Onondaga Co. Acad. Sci. 1, p. 120; Morse 1904, Proc. Ohio Acad. Sci. 4, p. 112; Henshaw 1904, Occ. Pap. Boston Soc. Nat. Hist. 7, 2, p. 4; Stone 1906, Amer. Nat. 40, p. 161; Fowler 1907, Rept. Rept. Amph. New Jersey, p. 62, pl. 11; Kingsbury and Reed 1908, Anat. Rec. 2, p. 82 (otic apparatus); 1908, Journ. Morph. 20, p. 576 (otic apparatus);

Reed and Wright 1909, Proc. Amer. Phil. Soc. 48, p. 403; Surface 1913, Zoöl. Bull. Pennsylvania Dept. Agric. 3, 3-4, p. 97, f. 9, pl. 6, f. 2; Keim 1915, Copeia 24, p. 51; Pope 1915, Copeia 19, p. 14; Dunn 1916, Copeia 28, p. 22; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 19; Stejneger and Barbour 1917, Check List, p. 19; Mattern 1917, Copeia 46, p. 64; Dunn 1918, Copeia 53, p. 19; 1918, Bull. Mus. Comp. Zoöl. 62, p. 465; Engelhardt 1918, Copeia 69, p. 70; Wright and Moesel 1919, Copeia 72, p. 64; Reed 1920, Journ. Morph. 33, p. 343; Dunn 1920, Proc. Biol. Soc. Washington 33, p. 132; Pope and Noble 1921, Copeia 100, p. 79 (food habits); Wright and Haber 1922, 105, p. 31 (food habits); Bishop 1923, Copeia 118, p. 66; Stejneger and Barbour 1923, Check List (2), p. 13; Holt 1924, Copeia 135, p. 94; Wilder 1924, Amer. Nat. 58, p. 539, f. 2b (premaxilla); Bishop 1925, Copeia 139, p. 11; Green 1925, Copeia 141, p. 32 (eggs).

1884 *Geotriton porphyritica* Garman, Bull. Essex Inst. 16, p. 40.

1838 *Salamandra salmonea* Holbrook, N. Amer. Herp. 3, p. 101, pl. 22 (Vermont); Storer 1839, Fish. Rept. Birds Massachusetts, p. 248; Holbrook 1842, N. Amer. Herp. (2), 5, p. 33, pl. 8; DeKay 1842, Zoöl. New York 3, p. 76, pl. 16, f. 39; Thompson 1842, Hist. Vermont, p. 119; Linsley 1844, Amer. Journ. Sci. Arts 46, p. 49; Fogg 1862, Proc. Portland Soc. Nat. Hist. 1, p. 86; Jones 1865, Proc. Trans. Nova Scotia Inst. Sci. 1, p. 127.

1849 *Pseudotriton salmoneus* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 287; Hallowell 1856, Proc. Acad. Nat. Sci. Philadelphia, p. 11; Verrill 1863, Proc. Boston Soc. Nat. Hist. 9, p. 199; Allen 1868, Proc. Boston Soc. Nat. Hist. 12, p. 200.

1850 *Spelerpes? salmonea* Gray, Cat. Batr. Grad. Brit. Mus., p. 46.

1854 *Ambystoma salmoneum* Dumeril and Bibron, Erp. Gen. 9, p. 111.

1858 *Pseudotriton salmonea* Hallowell, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 342; Abbott 1868, Geol. Surv. New Jersey, p. 803.

1866 *Spelerpes salmonea* Cope, Journ. Nat. Sci. Philadelphia (2), 6, p. 100; Parker 1879, Trans. Linn. Soc. London (2), 2, 3, 5, p. 191, pl. 18, f. 8, pl. 20, ff. 3-8.

1870 *Spelerpes salmoneus* Strauch, Mem. Acad. Sci. St. Petersbourg (7), 16, 4, p. 83.

1884 *Proteus* sp. Zipperlen, Zoöl. Gart. 25, p. 360 (Lookout Mt., Tenn.).

Type: Not known to exist. Collected by Jacob Green.

Type locality: French Creek, Meadville, Crawford Co., Pa.

Range: From Manchester, Me., and Ontario opposite Buffalo to Nelson Co., Va., Jackson Co., Ala., and Cincinnati, Ohio. Occupies the Appalachian uplift in all its divisions except the southern Blue Ridge; the Adirondacks; and the eastern edge of the central Low Plateau.

Diagnosis: A reddish salamander with angular canthus rostralis marked by a white line, tail much flattened, coloration clouded black and salmon red, no definite spots. Reaches 188 mm.

Description: M. C. Z. 4274, adult male; Tupper Lake, N. Y.; costal grooves 17; 7 costal folds between appressed toes; head width 7 in length from tip of snout to vent; head length 4½ in length of body; sides of head forming angles with the front as viewed from above; canthus rostralis well marked; eye as long as its distance from tip of snout; snout not swollen; a slight projection of upper lip below nostril; outline of upper jaw concave as viewed from side; angle of jaw well behind angle of eye; hind part of lower eyelid with groove into which upper fits so that part of lower is prolonged backwards spur fashion; a groove from eye along sides of head curving down to meet gular fold; latter on sides of neck to dorsal surface; a groove downwards from lateral groove to back of angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 2, 5, 1 in order of length; tail shorter than body, much flattened, keeled and finned dorsally throughout; anus with lips lined with papillae; vomerine series continuous with parasphenoids, beginning behind outside edge of nares, extending straight inwards and then backwards in a right angle to form two parallel rows separated by about half the length of the short side; light salmon, irregularly mottled and clouded with darker; sides and top of head dark; a light line from eye to nostril along canthus rostralis; a black streak immediately behind eye in groove on side of head; white beneath, no pigment to a line joining insertion of legs; total length 152 mm., head 17, body 75, tail 60.

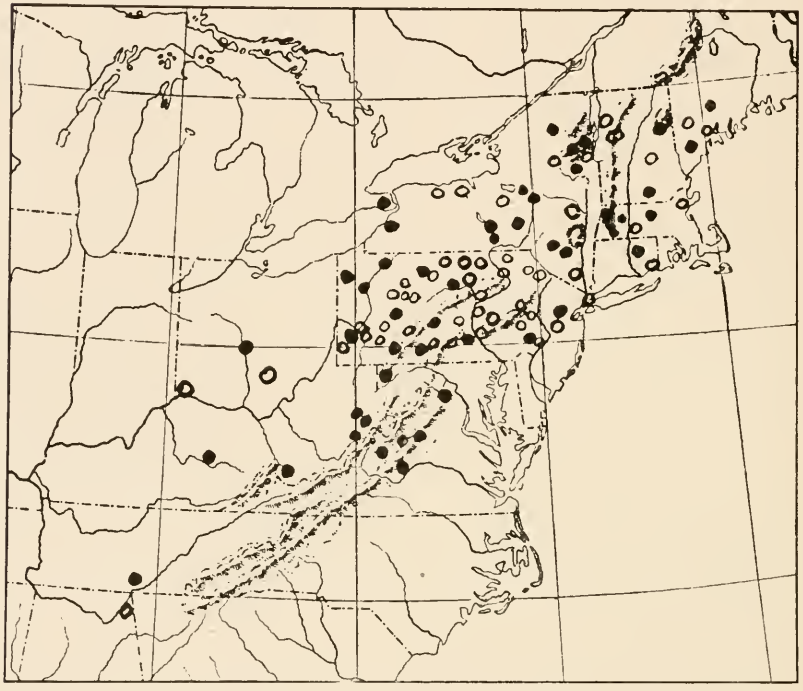
Variations: An adult female, M. C. Z. 5630, Jaffrey, N. H., agrees, save that the head width is 7½ in the length from tip of snout to vent; the head length 4⅓ in length of body; eye not so long as its distance from tip of snout; lips of anus not lined with papillae; vomerine making an acute angle; total length 174.5, head 20, body 86, tail 68.5.

A larva, M. C. Z. 4967, McBride's Pond, Adirondack Mts., N. Y., shows the following color: brownish reticulated with blackish, these reticulations especially prominent on the tail; no traces of larval areas; gills blackish, reaching from gular fold to forearm; under side unpigmented, save sides of throat in front of gular fold and tip of chin; total length 106 mm., head 13, body 47, tail 46.

Occasional specimens, probably old, show the dorsal color nearly black, such as M. C. Z. 5628, male, Midway, Va. This has also a few dots of black on the belly and a good many on the throat and the edge

of the lower lip; this specimen has 18 costal grooves, due to the addition of an imperfect fold back of the axilla.

The smallest transformed individual seen, from Endless Caverns, Va., had a very different color. It was light red with dark dots and much like *danielsi*. I feel sure that this specimen had transformed at



38. Eastern United States, showing localities for Gyrinophilus porphyriticus.

an abnormally small size as the next smallest transformed individual I have seen was much larger. Possibly the abnormally early transformation may account for the peculiar color and suggest that the color of *danielsi* is more primitive.

I have seen a specimen from Midway in which the premaxillae are fused (Wilder 1924).

Largest and smallest specimens seen:

Sex	*total length*	*head*	*body*	*tail*	*data*	
♂	192	22	98	72	U. S. N. M. No. 3840	Canonsburg, Pa.
♀	188	23	94	71	Pope 17	Manchester, Me.
yg.	115	15	54	46	M. C. Z. No. 7323	Midway, Va.
yg.	65	9	34	22	S. C.	Endless Caverns, Va.
Larva	114	15	53	46	E. R. D.	Midway, Va.
Larva	27	4	12	11	Pope 3	Manchester, Me.

Habits: Smith (1882) says that it occurs "in moist land under logs and in damp woods," one in captivity "appeared healthy for a year" and lived on "flies." Cope (1889) says, "this is the only one of our eastern salamanders which attempts self-defense. It snaps fiercely, but harmlessly, and throws its body into contortions *in terrorem*. It is quite aquatic but prefers the still waters of swamps or springs to running streams." Reed and Wright (1909) at Ithaca, N. Y., say, "Found in all cold springs and streams flowing through gorges or ravines. They remain in the larval stage for a period of two years at least. The only record of transformation we have obtained is a specimen 11.5 cm. long, found March 14, 1903, in which the larval characteristics have almost entirely disappeared. A female taken May 12, 1906, with mature eggs in the ovaries; and what appeared to be a larva not long after hatching taken from a cold brook, June 29, 1911, are the only clues we have to the breeding habits."

Surface (1913) examined 26 food-containing stomachs and found "earthworms, snails, undetermined crustacea, spiders, thousand-legged 'worms,' fly larvae and ground beetles principally."

Pope (1915) at Manchester, Me., says, "a cold spring rising in a barrel in an open field and emptying into a stone drain. One had been found in the mud under the board cover of the spring, while the others were in the water." Larvae were found "at the mouth of the stone drain, about 100 yards from the spring, and in the spring itself." Larvae an inch long which "appeared to be newly hatched" were taken April 19, 1915.

Engelhardt (1919) at 2,000 feet in the Catskills, Ulster Co., N. Y., says, "Captured singly under submerged rocks in shallow pools near the source of the spring-fed brook." Dr. H. H. Wilder caught two some years ago in a very swift brook at Hinsdale, Mass. He tells me that they swam very swiftly and were as agile and hard to catch as fish. Dr. Thomas Barbour, near Tupper Lake, in the Adirondacks,

caught a larva in a minnow trap in a deep stream and the specimen described was found under a rock in several feet of water near the shore of Big Tupper Lake.

Dr. G. M. Allen, of the Boston Society of Natural History, writes me that "R. M. Marble, of Woodstock, Vermont, lately sent us an alcoholic specimen of *Gyrinophilus* taken there about a year ago. It was dug up in repairing a road at about three feet below the surface."

Pope and Noble (1921) mention a specimen "captured under a log lying near the edge of a brook in Castle Shannon, Allegheny County, Pennsylvania," which ate several specimens of *Desmognathus fuscus* with which it was confined.

Wright and Haber (1922) says that at Ithaca it is most abundant in two localities. "One spot is where a large series of clear springs break out of a side hill to form a stream, and the other is a series of high mountain rivulets which are small ravines or nearly so. The species occurs in most of our single springs and larger ravines but its distribution is more diffuse and not so concentrated as in these two places." They also mention *Gyrinophilus* eating four-toed and two-lined salamanders *(Hemidactylium scutatum* and *Eurycea bislineata)* and a young wood frog as well as two larvae of its own species under conditions of captivity, and disgorging "dusky and two-lined salamanders or their larvae" "when killed," but consider them mainly insectivorous.

Green (1925) records the finding of fifteen eggs, by Mr. R. W. Wehrle, on August 8, 1924, near Indiana, Pa. "They were found in an old spring which was filled up with stones and brush and were clustered to the bottom of a fair sized stone over and around which the water was flowing. A number . . . of purple salamanders were found in this spring near the stone; no other species were found. Each egg is enclosed in an individual jelly-like transparent mass which maintains its spherical shape when in the water. They are about nine mm. in diameter and were fastened together and to the stone so tight that they were removed with difficulty."

I have taken thirteen adults and larvae in Nelson County, Va. These were either near springs in quite broad, open, valleys or in streams in narrow, dark, ravines. The adults seemed sluggish and easy to catch, but the larvae were very active.

Apparently the adult is rather a wanderer and is at home in a variety of situations. I have never seen it attempt to bite.

Remarks: It is very closely related to *danielsi,* which replaces it in the Southern Blue Ridge. As the color of *danielsi* is perhaps more primitive, certainly resembling much more the color of the Pseudotritons, and as the extreme youthful coloration of the present form is like that of *danielsi,* the southern form may represent the original type.

Specimens seen 139, as follows:

Canada: "Opposite Buffalo" 3 (M. C. Z. No. 1370).

Maine: Manchester 13 (Pope No. 3, 4, 17-8, 38, Bowdoin No. 212); North Gorham 3 (Portland No. 596-8).

New Hampshire: White Mts. 1 (M. C. Z. No. 996); Jaffrey 1 (Boston Soc.).

Massachusetts: Princeton 1 (M. C. Z., No. 2296); Hinsdale 2 (Smith); Chester 1 (Blanchard); Williamstown 9 (M. C. Z. No. 4483-8. U. Mich. No. 53099-101); Ashfield 1 (E. R. D.).

Connecticut: Storrs 1 (U. S. N. M. No. 22746).

New York: Hamburg 1 (Cornell); Central N. Y. 1 (A. N. S.); Ithaca 11 (U. S. N. M. No. 39404, Cornell); Berkshire, Tioga Co. 12 (M. C. Z. No. 198, 1240, 4577-82); Chenango Co. 1 (A. N. S.); Big Woodhull Creek, Oneida Co. 1 (Roy. Ont. Mus.); Mohawk, Herkimer Co. 1 (Carnegie No. 1665); Big Tupper Lake 1 (M. C. Z. No. 11903); McBride's Pond 1 (M. C. Z. No. 3976); Adirondack 1 (U. S. N. M. No. 3842); St. Hubert's 1 (A. M. N. H. No. 14539); Elizabethtown 1 (M. C. Z. No. 2279); Catskills 3 (U. S. N. M. No. 23181, 23184, 23191); Halcottsville, Delaware Co. 1 (Brooklyn Mus. No. 933); Big Indian Valley, Ulster Co. 3 (Brooklyn Mus. No. 1257-9).

New Jersey: Plainfield 1 (M. C. Z. No. *2302*).

Pennsylvania: Near Philadelphia 1 (A. N. S.); Carlisle, Cumberland Co. 8 (U. S. N. M. No. 3874, 8266, 14468); Round Island, Clinton Co. 1 (A. N. S.); Port Allegheny, McKean Co. 2 (U. S. N. M. No. 67106, A. N. S.); Warren Co. 1 (A. N. S.); Meadville 6 (U. S. N. M. No. 3852); Foxburg, Venango Co. 12 (U. S. N. M. No. 3841, 3847); Altoona 1 (A. N. S.); Indiana 1 (A. N. S.); Bedford Co. 1 (M. C. Z. No. 1000); Somerset Co. 2 (U. S. N. M. No. 57358-9); Cannonsburg, Washington Co. 1 (U. S. N. M. No. 3840).

Maryland: Jennings 1 (A. N. S.).

Virginia: Loudoun Co. 1 (Cornell); Stony Man Mt., Page Co. 3 (U. S. N. M. No. 3385-6, 31627); O'Connell's, Augusta Co. 7 (U. S. N. M. No. *36277, 36722, 36736, 36748*); Endless Caverns 1 (S. C.); Midway, Nelson Co. 10 (E. R. D., M. C. Z. No. 5628-9); Wingina, Nelson Co. 3 (E. R. D.); upper James River 1 (U. S. N. M. No. 3878).

West Virginia: Files Creek, Cheat Mt. Cove, Randolph Co. 1 (U. S. N. M. No. 33612); Durbin-Cheatbridge 1 (U. S. N. M.); Big Spring Run, Pocahontas Co. 1 (U. S. N. M. No. 33624); Morgantown 1 (U. S. N. M. No. 69583); Barrenshe Creek, McDowell Co. 1 (U. S. N. M. No. *33642*).

Ohio: Columbus Co. 1 (U. S. N. M. No. 3974).
Kentucky: Estill Co. 1 (U. S. N. M. No. 57357).
Tennessee: Lookout Mt. 1 (U. S. N. M. No. 12705).

It has also been recorded from the following localities:

Nova Scotia: (Jones 1865). This is a hearsay record and need not be taken seriously.
Maine: Brunswick (Pope 1915); Norway (Verrill 1863).
New Hampshire: Bridgewater (Howe 1904).
Vermont: Burlington (Thompson 1842); Woodstock and Bolton (G. M. Allen in litt.).
Massachusetts: Danvers (Holbrook 1842); Springfield (Allen 1868).
Connecticut: Stonington (Linsley 1844).
New York: Monroe Co. and Wayne Co. (Wright and Moesel 1919); Onondaga Co. (Britcher 1903); Newcomb, Essex Co. (DeKay 1842); Highland Falls (Mearns 1898); Indian Ladder and Vorheesville, Albany Co., and Chilson Lake, Essex Co. (Bishop 1923).
Pennsylvania: Castle Shannon, Allegheny Co. (Pope and Noble 1921); Swissvale and Pittsburgh, Allegheny Co.; Crothers, Washington Co.; Dayton, Armstrong Co.; Wilmore, Cambria Co.; Roundsville and Punxatawney, Jefferson Co.; Warren, Warren Co.; New Alexandria and Welty, Westmoreland Co.; Wellsboro, Tioga Co. (Surface 1913); Blossburg, Tioga Co., Lincoln Falls, Sullivan Co. (Bishop 1925); Odin and Westpike, Potter Co.; Marshrun, Duncannon and Loysville, Perry Co.; Asherton, Northumberland Co.; Danville, Montour Co.; Calvert, Lycoming Co. (Surface 1913); Loyalsock and Barbours, Lycoming Co. (Bishop 1925); Mifflin, Juniata Co. (Surface 1913); Tuscarora, Juniata Co. (Stone 1906); McConnellsburg, Fulton Co.; Dauphin, Harrisburg and Williamstown, Dauphin Co.; Enola, Cumberland Co.; La Jose, Clearfield Co.; Granville Summit, Bradford Co. (Surface 1913); Stevenson, Bradford Co., Charteroak, Huntingdon Co. (Bishop 1925); Kutztown, Berks Co.; Weissport, Carbon Co.; Allentown, Lehigh Co. (Surface 1913); Aineysville and Summit Lawn, Lehigh Co. (Mattern 1917); Bustleton, Philadelphia Co.; Auburn, Susquehanna Co.; Honesdale, Island Pond, and Waymart, Wayne Co.; and Falls, Wyoming Co. (Surface 1913).
New Jersey: Mercer Co. (Abbott 1885).
Ohio: Cincinnati (Boettger 1892); Sugar Grove (Morse 1904).
Alabama: Sand Mt., Jackson Co. (Holt 1924).

GYRINOPHILUS DANIELSI (BLATCHLEY)

1895 *Gyrinophilus porphyriticus* Rhoads, Proc. Acad. Nat. Sci. Philadelphia, p. 401; Brimley 1912, Proc. Biol. Soc. Washington 25, p. 140.
1900 *Spelerpes danielsi* Blatchley, Rept. Geol. Indiana 25, p. 762; Brimley 1907, Journ. Elisha Mitchell Sci. Soc. 23, p. 152; 1912, Proc. Biol. Soc. Washington 25, p. 140.
1917 *Gyrinophilus danielsi* Fowler and Dunn, Proc. Acad. Nat. Sci. Philadelphia, p. 19; Dunn 1917, Bull. Amer. Mus. Nat. Hist. 37, p. 613, pl. 49, f. 4;

Stejneger and Barbour 1917, Check List, p. 17; Dunn 1918, Bull. Mus. Comp. Zoöl. 62, p. 465; 1920, Proc. Biol. Soc. Washington 33, p. 132; Stejneger and Barbour 1923, Check List (2), p. 13; Bishop 1924, Bull. New York St. Mus. 253, p. 89, pl. 2, ff. 1-2 (breeding habits); Bishop 1925, Copeia 139, p. 10.

Types: M. C. Z. 6639, collected by Mr. Daniels.

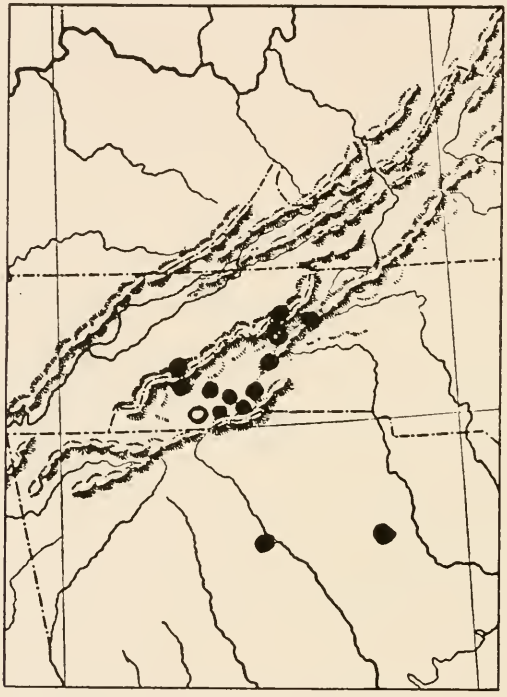
Type locality: Mt. Collins and Indian Pass, Sevier Co., Tenn.

Range: From Grandfather Mt., N. C., and Roan Mt., Tenn., to Mt. Collins, Tenn., and apparently southeast to Lincoln Co., Ga., and Columbia, S. C. (latter a larva, not in good state). It occupies the southern section of the Blue Ridge, and if the Georgia and South Carolina localities be correct it extends well out into the Piedmont.

Diagnosis: Similar to *G. porphyriticus* but lighter in color. Color clear with definite small dark spots instead of clouded. A dark line from eye to nostril. Reaches 167 mm.

Description: M. C. Z. 6639, adult male, Sevier Co., Tenn.; costal grooves 17; 7 costal folds between appressed limbs; head width 6 in length from tip of snout to vent; head length 4 in length of body; head broadly oval from above; faint traces of angles at the nostrils; canthus rostralis somewhat marked; eye as long as its distance from the snout; snout not swollen; a distinct projection of upper lip below nostril; outline of upper jaw straight as viewed from side, turned down at angle which is just back of hind angle of eye; hind part of lower eyelid with groove into which upper fits so that part of lower is prolonged backwards spur fashion; groove from eye backwards along sides of head curving down to meet gular fold; a groove downwards from this to back of angle of jaw; gular fold to dorsal surface on sides of neck; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 2, 5, 1 in order of length; tail shorter than body, much flattened, keeled and finned dorsally throughout; anus with lips lined with papillae; vomerine series continuous with parasphenoids, beginning outside outer edge of nares, extending straight inwards and then backwards in a right angle to form two parallel rows, separated by the length of the short side; salmon red above with irregular small black spots rather sparsely scattered over the dorsal surface of body, tail, head, and limbs and on throat; a black line from eye to nostril just below canthus rostralis; white beneath a line joining insertions of legs; total length 140 mm., head 18, body 70, tail 52.

Variation: An adult female, M. C. Z. 2890, Sunburst, N. C., is similar but has 6 costal folds between the appressed toes; the head length 3½ in length of body; head rather blunt in front; eye some what shorter than its distance from tip of snout; no distinct projection of upper lip below nostril; both eyelids fitting under a fold of skin at back; anal lips without papillae; vomerines forming a very acute angle;



39. Southern mountains, showing localities for Gyrinophilus danielsi.

total 107, head 15, body 53, tail 39. A larva, M. C. Z. 5633, Linville, N. C., is uniform dusky above; white below save for chin, lips, and sides of throat anterior to the gular fold; a dusky line back from chin on median line of throat; gills pigmented, reaching from gular fold to fore limb; total length 103, head 13, body 48, tail 42. Occasional specimens as in *G. porphyriticus* show 18 costal grooves.

The color may vary from many, rather thickly scattered, small dots to few rather large ones and the throat may be immaculate save for a few dots in the edge of the lower lip or covered with a reticulate pattern of black.

Largest male	167	21	84	62	U. S. N. M.	35596	Gt. Smoky Mts.
Largest female	137	18	63	56	U. S. N. M.	30007	Swain County, N. C.
Largest larva	110	13	52	45	M. C. Z.	5635	Black Mt., N. C.
Smallest adult	107	15	53	39	M. C. Z.	2890	Sunburst, N. C.
Smallest larva	28	5	12	11	M. C. Z.	7325	Linville, N. C.

In this smallest larva the larval areas can be made out. An upper row of few small, widely separated spots and the middle row of rather more areas yet of the same size.

Bishop (1924) considers that specimens from lower altitudes in the North Carolina mountains are somewhat different from those taken higher up and "present certain characters which may prove of subspecific value when a larger series is available for comparison. These characters may be summarized briefly as follows: The average size is considerably below that of the high mountain forms; the underparts, including the throat are entirely lacking in pigment, the lower lip only being narrowly margined; the sides of the head below and in front of the eyes are less strongly pigmented and finally, the tail is usually less pigmented distally; particularly on the lower half of the sides . . . all adult specimens from the summit of Mount Mitchell are pigmented below, the extent apparently depending on the age of the animal. The larger specimens from lower altitudes are certainly mature and exceed in size the smaller individuals from higher levels but lack entirely the pigmentation of the venter."

He took 17 adults at "6,000 feet and above" on Mt. Mitchell. They ranged in length from 120-204 mm.

It is hard to comment on this situation on account of the lack of material. Scarcely more than 20 adults had been taken anywhere until Bishop's success on Mt. Mitchell. Some of these, especially the types, were pigmented on the throat. Unfortunately, there is no exact altitude data on these specimens. It may be noted that the area over 6,000 feet in the Southern Blue Ridge is comparatively small and is best developed in the Blacks, whence came Bishop's specimens, and in the Smokies, whence came the types. On the other hand, larvae and young of *Gyrinophilus* are so much easier collected, and so much commoner in collections, than adults, that one is a little inclined to

wonder whether "the larger specimens from lower altitudes are certainly mature." There is little difference, save in color, between *porphyriticus* and *danielsi* and in the former mature adults are 150 mm. or more long. The coincidence that the largest and most complete collection of these animals ever made, which is from one locality, contains more large individuals, larger individuals, and individuals more pigmented on the venter may hang more on the completeness of the collection, than on the altitude of the locality.

Habits: Rhoads (1895) caught one specimen "under the upper bark of a huge hemlock log in the deciduous belt of Roan Mountain at about 4,000 feet elevation . . . the nearest stream of water being fifty yards from the tree on which I found the specimen." Brimley (1912) says "Cane River . . . under a log lying in water" and "a more serpentine motion in life than most salamanders, and seems to be wholly aquatic and of somewhat mud-burrowing habits . . . only in places where the bed of the stream is somewhat boggy in character." These latter statements for Blantyre and Sunburst. Specimens of my own collecting include one adult and 10 larvae from Linville, Pisgah Forest Reserve, and Brevard. The larvae were all taken in rocky streams, usually hiding under a half submerged log or stone. They were exceedingly active swimmers and rather difficult to catch. The adult was under a fallen log on land, the nearest water being a boggy spring some fifty yards off. It was quite sluggish.

Bishop (1924) says of specimens collected at Steprock Creek, Mt. Mitchell, 6,000 feet and above, "found by turning the large flat stones in the bed or along the margins . . . I was fortunate to find a large female guarding her young which were just ready to hatch from the gelatinous envelops attached to the under side of a large stone in comparatively still water. The eggs had apparently been attached separately when laid, like those of *Eurycea bislineata,* but at the time of discovery, disintegration of the gelatinous coverings and absorption had so far advanced that an area about 7 by 8 inches was entirely covered by a thick layer of jelly. Close examination showed that the individual larvae were inclosed by envelops one-half to three-quarters of an inch in diameter. A dozen larvae were collected as they wriggled out of the jelly mass and made their way into the water. . . . The average length of nine larvae is 25.8 mm."

Remarks: The only near relative is *G. porphyriticus. Danielsi* in

color and in proportions seems the more primitive of the two. The head is longer and this denotes less bodily elongation (which is always secondary). The color is nearer to that of *Pseudotriton*, and the peculiar mottling of *porphyriticus* is not found elsewhere in the allied genera. Yet the two are very close and may eventually be proven to intergrade. They are vicarious forms. This animal was not recognized as distinct from *G. porphyriticus* until a late date, no fresh adult material having fallen into the hands of a herpetologist until Blatchley received his types. As *danielsi* was originally described as a *Spelerpes* various specimens from North Carolina were recorded in literature as *G. porphyriticus* after Blatchley described *danielsi*.

Specimens seen 40, as follows:

Tennessee: No locality (probably Great Smoky Mts.) 2 (U. Mich. No. 42461, U. S. N. M. No. 35596); Sevier Co. 2 (M. C. Z. No. 6639 TYPES); Roan Mt. 1 (A. N. S. No. 4353).

North Carolina: Roan Mt. 2 (A. N. S. No. 10566-7); Linville 8 (M. C. Z. No. 5631-4, A. M. N. H. No. *21186-9*); Black Mt. 2 (M. C. Z. No. *5635*, U. S. N. M. No. *49564*); Blantyre 4 (U. S. N. M. No. 38227-30); Flat Rock 2 (A. M. H. No. 21177, *21198*); Brevard 5 (A. M. N. H. No. *4147*, *4149-50*, *4365*, *4476*); Pisgah Forest Reserve 3 (U. Mich. No. 52531, A. M. N. H. No. *4391*, *4438*); Haywood Co. 1 (U. S. N. M. No. 57120); Sunburst 1 (M. C. Z. No. 2890); Swain Co. 1 (U. S. N. M. No. 30007).

South Carolina: Columbia(?) 1 (U. S. N. M. No. *5812*).

Georgia: Lincoln Co. 1 (A. N. S. No. 512); upper Georgia 4 (U. S. N. M. No. 4716-9).

Brimley (1912) records it from Cane River, N. C., and (in litt.) from Cowee Mt., N. C. Bishop (1924) records it from Steprock Creek, Mt. Mitchell (6,000 feet and above); Mt. Mitchell, 4,500 feet; Grandfather Mt. (4,000 feet); and Stoney Mt., near Hendersonville (2,500 feet), and(1925) from Hanging Rock Mt., Avery Co., Linville Gap Cr., Linville Mt., and Elk Cr., Mitchell Co. Cope (1889) records it from Abbeville, S. C., and from Riceboro, Ga. The latter locality is extremely dubious.

PSEUDOTRITON TSCHUDI

1838 *Pseudotriton* Tschudi, Mem. Soc. Sci. Nat. Neuchatel, p. 60 (type *subfusca*).
1839 *Mycetoglossus* Bonaparte, Fauna Italica, Fsc. 26 (substitute name).
1843 *Batrachopsis* Fitzinger, Syn. Rept., p. 34 (type *subfusca*).
1848 *Pelodytes* Gistel, Naturgeschichte, p. 11 (substitute name; not *Pelodytes* Fitzinger 1838, in Bonaparte, Fauna Italica).
1854 *Bolitoglossa* Duméril and Bibron, Erp. Gen. 9, p. 88 (partim.).

Diagnosis: Tongue free all around; one premaxilla, nasal spines fused, a fontanelle; a septomaxilla; maxilla normal; prefrontals present, bordering nares; internal nares a notch in prevomer; vomerine and parasphenoid series continuous; condyles sessile; atlas normal; eyes functional; gills of larva with long rami; 3 epibranchials; no marked sexual dimorphism; tail not constricted at base; toes 4-5, free; terminal phalanges T-shaped; no palmar tubercles; five forms.

Range: Eastern United States, south of New England and New York (except Indiana, Illinois, and southern Florida).

Key to adults of *Pseudotriton:*

A. Many irregular black dots.
  B. Black dots run together in adult. . . . . *ruber* 272
  B B. Black dots do not run together in adult.
    C. Chin black, dots on distal half of tail. . . . . *schencki* 283
    C C. Chin not black, no dots on distal half of tail. . *nitidus* 281
A A. Few circular black dots.
  B. Larger, legs longer. . . . . *montanus* 286
  B B. Smaller, legs shorter. . . . . *flavissimus* 291

PSEUDOTRITON RUBER RUBER (SONNINI)

1799? *Siren operculata* Beauvois, Amer. Phil. Trans. 4, p. 279 (opposite Philadelphia); Say 1818, Journ. Acad. Nat. Sci. Philadelphia 1, p. 405.
1802 *Salamandra rubra* Sonnini, in Latreille, Hist. Nat. Rept. 4, p. 305; Daudin 1804, Hist. Nat. Rept. 8, p. 227; Say 1818, Journ. Acad. Nat. Sci. Philadelphia 1, p. 405; Harlan 1826, Journ. Acad. Nat. Sci. Philadelphia 5, p. 332; Holbrook 1838, N. Amer. Herp. 4, p. 123, pl. 27; 1842, id. (2), 5, p. 35, pl. 9; DeKay 1842, Nat. Hist. New York 3, p. 80, pl. 17, f. 43; Hough 1852, Report New York State Mus., p. 24.
1820 *Molge rubra* Merrem, Syst. Amph., p. 185.
1849 *Pseudotriton ruber* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 286; 1852, Report New York State Mus., p. 22; Hallowell 1856, Proc. Acad. Nat.

Sci. Philadelphia, p. 11; 1856, l. c., p. 101; 1858, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 347; Abbott 1868, Geol. Surv. New Jersey, p. 803; Dunn 1918, Copeia 53, p. 19; Noble 1922, Bull. Amer. Mus. Nat. Hist. 46, p. 46 (thigh muscles); 1918, Bull. Mus. Comp. Zoöl. 62, p. 466; Wilder 1924, Amer. Nat. 58, p. 539, f. 2c (premaxilla); Noble 1925, Journ. Morph. 40, p. 372, f. 16, 20 (skin).

1920 *Pseudotriton ruber ruber* Dunn, Proc. Biol. Soc. Washington 33, p. 133; Blanchard 1922, Occ. Pap. Mus. Zoöl. U. Michigan 117, p. 4; Stejneger and Barbour 1923, Check List (2), p. 15; Bishop 1923, Copeia 118, p. 66; Holt 1924, Copeia 135, p. 94; Bishop 1924, Bull. New York St. Mus. 253, p. 91; Bishop 1925, Nat. Hist. 25, p. 385 (eggs).

1850 *Spelerpes rubra* Gray, Cat. Batr. Grad. Brit. Mus., p. 45; Cope 1866, Journ. Acad. Nat. Sci. Philadelphia (2), 6, p. 106; Parker 1879, Trans. Linn. Soc. London (2), 2, 3, 5, p. 191, pl. 18, f. 10, pl. 19, f. 9, pl. 20, ff. 1-2, 9, pl. 21, ff. 1-5 (skull); Clark 1905, Report Michigan Acad. Sci. 7, p. 110.

1869 *Spelerpes ruber* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 107; Cragin 1881, Trans. Kansas Acad. Sci. 7, p. 122; Bicknell 1882, Trans. Linn. Soc. New York 1, p. 124; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 62; Smith 1882, Rept. Amph. Ohio, p. 728; Cope 1883, Proc. Acad. Nat. Sci. Philadelphia, p. 24 (gills); Davis and Rice 1883, Bull. Chicago Acad. Sci. 1, p. 27; Hoy 1883, Geol. Wisconsin 1, p. 426; Yarrow 1883, Bull. U. S. Nat. Mus. 24, p. 22, 157; Davis 1884, Proc. Nat. Sci. Ass. Staten Is. 1, p. 13; Abbott 1885, Nat. Rambles, p. 344, 477 (voice); Fisher 1887, Amer. Nat. 21, p. 672; Cope 1888, Journ. Morph. 2, p. 297, pl. 22, f. 16 (otic region); Cope 1889, Bull. U. S. Nat. Mus. 34, p. 172, f. 43, pl. 29, pl. 30, ff. 1-5, pl. 32, ff. 1-3, pl. 35, ff. 7-10, pl. 40, ff. 1-2, pl. 45, f. 6, pl. 48, f. 16; Garman 1891, Bull. Illinois Lab. Nat. Hist. 3, p. 361; Worthen 1891, Vert. Hanover, N. H., p. 61; Higley 1892, Proc. Wisconsin Acad. Sci. 7, p. 172; Rhoads 1895, Proc. Acad. Nat. Sci. Philadelphia, p. 401; Sherwood 1895, Proc. Linn. Soc. New York 7, p. 30; Brimley 1896, Amer. Nat., p. 500; Wilder 1896, Anat. Anz. 12, p. 183 (lunglessness); Mearns 1898, Bull. Amer. Mus. Nat. Hist. 10, p. 303; Moore 1900, Proc. Acad. Nat. Sci. Philadelphia, p. 613 (vertebrae); Morse 1901, Ohio Nat. 1, 7, p. 115; Hay 1902, Proc. Biol. Soc. Washington 15, p. 126; Britcher 1903, Proc. Onondaga Acad. Sci. 1, p. 121; Henshaw 1904, Occ. Pap. Boston Soc. Nat. Hist. 7, 2, p. 5; Morse 1904, Proc. Ohio Acad. Sci. 4, p. 114; Ditmars 1905, Amer. Mus. Nat. Hist. Journ. 5, 4, p. 176, f. 11; Stone 1906, Amer. Nat. 40, p. 162; Whipple 1906, Biol. Bull. 10, p. 257 (ypsiloid apparatus); 1906, Biol. Bull. 11, p. 1 (naso-labial groove); Brimley 1907, Journ. Elisha Mitchell Sci. Soc. 23, p. 152; Fowler 1907, Rep. New Jersey Mus. 1906, p. 69, pl. 14; 1908, id. 1908, p. 395; Kingsbury and Reed 1908, Journ. Morph. 20, p. 577 (otic apparatus); Allard 1909, Science (N. S.) 30, p. 122; Boulenger 1910, Les Batraciens, p. 54 (neoteny); Surface 1913, Bull. Pennsylvania Dept. Agric. 3, 3-4, p. 101, f. 12, pl. 7, f. 1; Deckert 1914, Copeia 13; Brimley 1915, Journ. Elisha Mitchell Sci. Soc. 30, p. 5; Dunn 1915, Copeia 16; 1915, id. 21, p. 28; 1915, id. 25, p. 63; Geyer 1915, Blätt. Aquar. Terr. 26, p. 86; Fowler 1915, Proc. Delaware Co. Inst. Sci. 7, p. 8; 1915, Copeia 22, p. 38; Dunn 1916, Copeia 28, p. 22; 1917,

Proc. U. S. Nat. Mus. 53, p. 396, ff. 9-11; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 19; Fowler 1917, Copeia 40, p. 14; Brimley 1917, Proc. Biol. Soc. Washington 30, p. 87; 1918, Journ. Elisha Mitchell Sci. Soc. 34, p. 149; Smith 1920, Journ. Morph. 33, p. 353 (branchial arches); Reed 1920, Journ. Morph. 33, p. 343 (otic apparatus); Dunn 1920, Aquatic Life, p. 119; Crozier 1924, Amer. Nat. 58, p. 480.

1854 *Bolitoglossa rubra* Dumeril and Bibron, Erp. Gen. 9, p. 89.

1884 *Geotriton rubra* Garman, Bull. Essex Inst. 16, p. 39.

1917 *Eurycea rubra rubra* Stejneger and Barbour, Check List, p. 20; Evermann 1918, Copeia 58, p. 67; Potter 1920, Copeia 86, p. 82; Löding 1922, Alabama Mus. Pap. 5, p. 15.

1925 *Eurycea rubra* Fowler, Copeia 145-6, p. 58, 62, 65.

1818 *Salamandra maculata* Green, Journ. Acad. Nat. Sci. Philadelphia 1, p. 356; Harlan 1826, Journ. Acad. Nat. Sci. Philadelphia 5, p. 331; Storer 1839, Report Fish Rept. Birds Massachusetts, p. 252; Linsley 1844, Amer. Journ. Sci. Arts 46, p. 50; Fogg 1862, Proc. Portland Soc. Nat. Hist. 1, p. 86; Wied 1865, Nova Act. Leop.-Car. 32, p. 129.

1818 *Salamandra subfusca* Green, Journ. Acad. Nat. Sci. Philadelphia 1, p. 351; Harlan 1826, Journ. Acad. Nat. Sci. Philadelphia 5, p. 331.

1838 *Pseudotriton subfuscus* Tschudi, Mém. Soc. Sci. Nat. Neuchâtel, p. 60.

1839 *Mycetoglossus subfuscus* Bonaparte, Fauna Italica, Fsc. 26.

1843 *Batrachopsis subfuscus* Fitzinger, Syst. Rept., p. 34.

1818 *Salamandra rubriventris* Green, Journ. Acad. Nat. Sci. Philadelphia 1, p. 353 (Princeton, N. J.; not of Daudin, 1804, Hist. Nat. Rept. 8, p. 239); Say 1818, Journ. Acad. Nat. Sci. Philadelphia 1, p. 405.

1818 *Proteus neocaesariensis* Green, Journ. Acad. Nat. Sci. Philadelphia 1, p. 358 (New Jersey); Say 1818, Journ. Acad. Nat. Sci. Philadelphia 1, p. 405.

1865 *Salamandra brevicauda* Wied, Nova Act. Leop.-Car. 32, p. 127 (Pennsylvania).

Type: Not known to exist. Collected by Palisot de Beauvois.

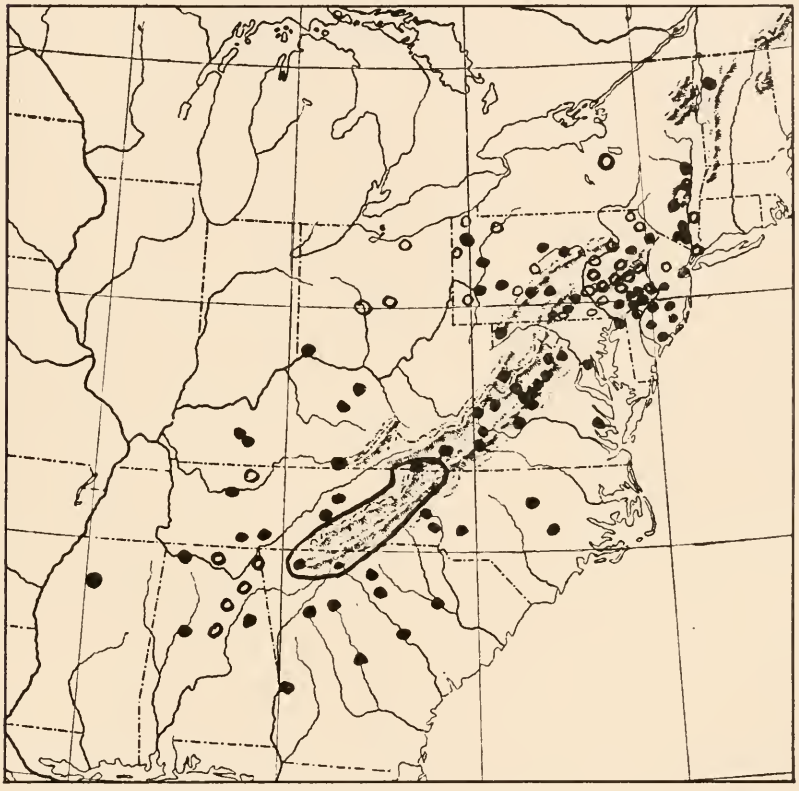
Type locality: "Les Etats Unis." (Probably near Philadelphia).

Range: From Vorheesville, Albany Co., New York, to Cincinnati, Ohio, Edmonson Co., Ky., Oxford, Miss., Columbus, Ga., Goldsboro, N. C., Gloucester, Va., and Cape May, N. J. Replaced by other races in the Southern Blue Ridge.

Diagnosis: A *Pseudotriton* with no dark ground color; chin without black bands; spots on distal half of tail; spots running together in adult; 16 costal grooves; vomero-parasphenoid series of teeth well separated from its fellow of the opposite side; total length to 166 mm.

Description: M. C. Z. No. 5637, adult male, Raleigh, N. C., 16 costal grooves; 6 costal folds between appressed toes; head width 5½ in length from tip of snout to vent; head length 4 in length of body; head oval; eye as long as its distance from tip of snout; snout rounded;

outline of upper jaw straight as viewed from side; angle of jaw back of hind angle of eye; hind part of lower eyelid with groove into which upper fits so that part of lower is prolonged backwards spur fashion; an ill-defined groove from eye back and down behind angle of jaw; a



40. Eastern United States, showing localities for Pseudotriton ruber ruber (ranges of P. r. nitidus and P. r. schencki in outline in center).

groove on side of neck from this point to the gular fold; latter on sides of neck to dorsal surface; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 2, 5, 1 in order of length; tail shorter than body, ovoid in section, ridged throughout dorsal surface; anus with lips lined with papillae; vomerine and parasphenoid series continuous,

beginning beyond outer edge of nares, curving slightly inward and forward, forming an acute angle, and thence backwards, separated from fellow series by width of nares; dark purplish red on whole dorsal surface of head, body, limbs and tail; belly light salmon with many small irregular grayish spots which are often scarcely distinct from each other, these more thickly crowded on edge of lower lip and on mid-line of belly; total length 143, head 18, body 72, tail 53.

Variation: A female, M. C. Z. 5636, Raleigh, N. C., differs as follows: head width 6 in length from tip of snout to vent; head length 4½ in body; anal lips smooth; vomerine teeth forming a right angle; color nearly similar to that described but with irregular black spots as large as eye, and these have indefinite borders over the dorsal surface; total length 129, head 15, body 69, tail 45 (imperfect).

A larva, M. C. Z. No. 5658, Anniston, Ala., differs in having 5 costal folds between the appressed toes, head width 5 in length from snout to vent, head length 3½ in length of body; the color is rather uniform dark above with a dusky edge to the lower lip; upper row of larval areas quite distinct as small circular unpigmented dots, about one to a costal fold although not arranged with reference to them; middle row similar in size of areas, but more numerous, about two to a costal fold; lower row not evident; total length 66, head 9, body 31, tail 26.

Largest male	146	18	77	51	U. S. N. M. No. 8818 Hamilton Co., Ohio
Largest female	166	20	79	67	U. S. N. M. No. 64014 Plummer's Is., D. C.
Largest larva	110				E. R. Dunn, Haverford, Pa.
Smallest adult	72	10	39	23	E. R. Dunn, Alexandria, Va.
Smallest larva	22	3	10	9	E. R. Dunn, Haverford, Pa.

Habits: Of this, the first member of the family to be described, and one of the commoner salamanders in the East very little is definitely known. It is usually found in springs. Its aquatic larvae grow nearly as large as the adult and may be found of very different sizes at the same time and place, suggesting at least two years in the larval stage. Cope (1889) says "its chief haunts are cold springs. Here, beneath stones, it may be always found occupying, if possible, the fissure from which the limpid water rises, and displaying its beautiful hues through the transparent medium with the brilliancy of a strange exotic, rather than the pallor of a dweller in the chilly depths and dark recesses of a cave." Surface (1913) says, "The food found in 59

stomachs consisted of earthworms, snails, slugs, spiders, thousand-legged 'worms,' numerous forms of insects and their larvae, and plant material." A spicewood seed was the only identified vegetable material found. Vertebrate food was composed of 4 unidentified salamanders, one *Plethodon cinereus* and one frog skin.

Abbott (1885, p. 344) says this species has a voice. I have never heard it or any other Plethodont make a sound, and the lack of lungs would seem to be an insuperable obstacle in the way of vocal demonstrations.

Ditmars (1905) claims that the "eggs are deposited early in the spring in the deeper pools of brooks."

Bishop (1925) says of the eggs that they "are laid in the fall (in the north at least). The young hatch in early winter. The eggs of a single female may number seventy or more. They are attached to the under surface of stones buried deep in the bed of a spring or stream, where they may be bathed in the coolest waters. The individual eggs, enclosed in gelatinous envelopes, are suspended on slender stalks, which flatten out at the point of contact with the stone to form an attachment disk. The eggs are clustered in little patches of a dozen or more, and the entire complement may cover an area several inches across.

"The larvae which hatch in November reach a length of about one inch by April or May. Other salamanders collected at this time of the year will measure about two inches in length and represent the growth of eighteen months. The largest larvae will have a length of four inches or more and be about thirty months old.

"Mr. M. K. Brady of Washington, D. C., has informed the writer that females dissected in December had mature eggs in the ovaries and that he found a batch of eggs in the field on February 10, 1915."

Hallowell (1856) says that females in the neighborhood of Philadelphia had developed eggs in the ovaries on April 28.

Dunn (1915) describes the transformation of two individuals during late May and early June at Haverford, Pa. He also (1920) gives a brief account of the habits at that locality.

While *ruber* is usually found in springs, I have several times found them under logs away from water.

Boulenger (1910) speaks of neoteny as taking place in this species, but he gives no details, and I can find no other reference to this.

Remarks: Many of the early records included specimens of *montanus,* and of the two southern races *schencki* and *nitidus.*

The *Siren operculata* Beauvois is figured as having 16 costal grooves and the dorsal fin of an Ambystomid larva. It is unidentifiable as it stands, but Say may have seen the specimen, so that I include it with a query. The other names are all obviously applicable.

Specimens seen 736, as follows:

Maine: Deer Island and Eagle Island(?) 7 (E. R. D.).

Vermont: Burlington 1 (U. S. N. M. No. 3833).

New York: Vorheesville 2 (N. Y. St. Mus); West Shokan 2 (A. M. N. H. No. 2349-50); Woodstock, Ulster Co. 8 (U. S. N. M. No. 61110-2, 61115-9); West Point 2 (M. C. Z. No. 5648, Brook. Mus. 1252); Highland Falls 1 (U. S. N. M. No. 23293); Greenwood Lake Glens 1 (Brook. Mus. No. 746); Long Island 4 (A. M. N. H. No. 2480-3); Staten I. 1 (A. N. S.); no locality 6 (A. M. N. H. No. 457, 470, 616, 681, 1010-1).

New Jersey: Edgewater 1 (A. M. N. H. No. 2476); Ridgewood 1 (M. C. Z. No. 2408); Hudson Heights 2 (A. M. N. H. No. 3740-1); Spring Valley 3 (A. M. N. H. No. 3674-6); Englewood 1 (A. M. N. H. No. 3501); Plainfield 3 A. M. N. H. No. 5381, M. C. Z. No. 2302); Maplewood 2 (Brook. Mus. No. 91, Cornell); South Orange 3 (A. M. N. H. No. 2477-9); Schooley's Mt. 1 (M. C. Z. No. 159); Culver's Lake 1 (Carnegie No. 3076); Trenton 2 (U. S. N. M. No. 9328-9); Princeton 1 (Carnegie No. 1720); Camden 1 (A. N. S.); Pointville 1 (U. S. N. M. No. 5392); Vineland 1 (Cornell); Stafford's Forge 1 (A. N. S.); Cape May Co., Petticoat Bridge and Crooked Creek 2 (A. N. S.).

Pennsylvania: Philadelphia Co.: Holmesburg 1 (A. N. S.); Germantown 3 (A. N. S.); Fairmount Park 3 (A. N. S.); Philadelphia 1 (A. N. S.); Delaware Co. 3 (U. S. N. M. No. 3865); Llanerch 1 (A. N. S.); Haverford 50 (E. R. D.); Montgomery Co.: Gladwyne 1 (A. N. S.); Naylor's Run 1 (A. N. S.); Conshohocken 1 (E. R. D.); Norristown 10 (H. C., M. C. Z. No. 170, 1412); Ogontz 3 (E. R. D.); Chester Co.: Devon 1 (A. N. S.); Monocacy 1 (A. N. S.); Londongrove 2 (M. C. Z.); Bucks Co.: Woodbourne 1 (A. N. S.); Pike Co. 1 (U. S. N. M. No. 51186); Milford 5 (U. S. N. M. No. 53394-8); Cumberland Co.: Pine Grove 1 (A. N. S.); Carlisle 304 (U. S. N. M. No. 3835-7, 3859, 3934, 7903); Monroe Co.: Henryville 1 (Carnegie No. 142); Mifflin Co.: Newton Hamilton 1 (A. N. S.); Diamond Valley 1 (A. N. S.); Clinton Co.: Round Island 1 (A. N. S.); Lock Haven 1 (Carnegie No. 1722); Blair Co.: Brush Mt. 1 (A. N. S.); Indiana Co.: Pine Creek 1 (A. N. S.); Allegheny Co. 3 (Carnegie No. 2766-8); Pittsburgh 2 (Carnegie No. 144-5, 2770-1); Venango Co.: Foxburg 16 (U. S. N. M. No. 3845, 3849, 11705); Meadville 3 (U. S. N. M. No. 3854).

Delaware: Wilmington 1 (A. N. S.).

Maryland: Jennings 1 (A. N. S.); Sebysville 1 (Carnegie No. 2769); Cecil Co.: Bacon Hill 1 (A. N. S.); Elk Neck 1 (A. N. S.); Bohemia Manor 1 (A. N. S.); Prince George Co. 1 (U. S. N. M. No. 64939).

District of Columbia: Plummer's Island 1 (U. S. N. M. No. 64014); D. C. 15 (U. S. N. M. No. 7820, 13313, 17096-9, 17103-4, 26392-3, 31101, 42934, 55466-7, U. Mich. No. 36090).

Virginia: Fairfax Co.: Ft. Myer 2 (E. R. D.); High School 14 (E. R. D.); Munson's Hill 8 (U. S. N. M. No. 17665-6, E. R. D.); Viresco 1 (U. S. N. M. No. 55232); Falls Church 1 (U. S. N. M. No. 10311); Great Falls 3 (U. Mich. No. 36088, 52318-9); Five Oaks 5 (U. S. N. M. No. 65915-9); Dyke 1 (U. S. N. M. No. 55473); no locality 2 (U. Mich. No. *52277*, U. S. N. M. No. 67411); Loudoun Co.: Bluemont 1 (Cornell); Clarke Co. 1 (U. S. N. M. No. 3866); Clarke Co.: Berry's Ferry 2 (E. R. D.); Fauquier Co.: Plains 2 (E. R. D.); Gloucester Co. 3 (U. S. N. M. No. 3882); Rockingham Co.: Rawley 1 (U. S. N. M. No. 13583); Endless Caverns 4 (S. C.); Page Co.: Thornton 3 (U. S. N. M. No. *59896-8*); Crozet 1 (M. C. Z. No. *5224*); Augusta Co.: Deerfield 1 (A. N. S.); O'Connell's 9 (U. S. N. M. No. *36766, 36722, 36758*); Bath Co.: Nimrod Hall 1 (E. R. D.); Nelson Co.: Midway 12 (M. C. Z. No. 5640-2, E. R. D.); Bedford Co.: Peaks of Otter 1 (U. S. N. M. No. 36712); Buchanan 1 (U. Mich. No. 42828); Wytheville 2 (U. S. N. M. No. 14420, 21232).

North Carolina: Morganton 1 (U. S. N. M. No. 9120); Raleigh 4 (S. C., M. C. Z. No. 5636-8); Goldsboro 1 (U. S. N. M. No. 8839); Catawba Co. 1 (M. C. Z. No. 1381); Concord 3 (A. M. N. H. No. 6415-7); no locality 1 (A. M. N. H. No. 2523).

South Carolina: Abbeville 8 (U. S. N. M. No. 2073, 3838); Anderson 4 (U. S. N. M. No. 3863); Columbia 2 (U. S. N. M. No. 8811); Hamburg 2 (U. S. N. M. No. *61234, 61237*).

Georgia: Thompson's Mills, Jackson Co. 1 (U. S. N. M. No. 38835); Gwinnett Co. 1 (U. S. N. M. No. 38549); Millidgeville 2 (M. C. Z. No. 185); Columbus 1 (U. S. N. M. No. 4024); no locality 20 (M. C. Z. No. 195, 210, 217, 4532, *4562-8*).

Alabama: Anniston 25 (M. C. Z. No. 5651-75); Florence 1 (E. R. D.); University 23 (U. Ala.); Hagler 1 (U. Ala.); Tuscaloosa Co. 2 (U. S. N. M. No. 56165-6).

Mississippi: Oxford 1 (U. Mich. 52445).

West Virginia: Franklin 1 (U. S. N. M. No. 26204).

Ohio: Hamilton Co. 1 (U. S. N. M. No. 8818); Cincinnati 1 (U. S. N. M. No. 8841); no locality 1 (A. N. S.).

Kentucky: Morgan Co. 2 (U. S. N. M. No. 57180-1); Tygart's Creek, Carter Co. 3 (M. C. Z. No. *1243*); Cumberland Gap 3 (M. C. Z. No. 4664-6); Edmonson Co. 1 (M. C. Z. No. 999); Mammoth Cave 6 (M. C. Z. No. 1680); Bee Spring 10 (M. C. Z. No. 995, 2220, 4558-61, *4738-41*).

Tennessee: Blount Co. 1 (U. S. N. M. No. 3900); Franklin Co. 2 (U. S. N. M. No. 57277-8); Sawyer's Springs 3 (A. N. S.); Knoxville 1 (M. C. Z. No. 223); Nashville 1 (E. R. D.); Como 1 (U. Mich. No. 53417); Henry 9 (U. Mich. No. *53288*, 53412-16, 53574-6).

The Maine specimens are very probably not from Maine, and the Vermont specimen also may be wrongly recorded.

It has also been recorded from the following localities:

Maine: Fogg (1862); Allen (1868). The former names no locality; the latter quotes Verrill (1863, Proc. Boston Soc. Nat. Hist. 9, p. 199) as saying that this species is "frequent" "in cold rocky brooks," but Verrill uses these very words about *Desmognathus fuscus* and does not mention the present form.

New Hampshire: White Mountains (Henshaw 1904). This is based on a specimen of *Gyrinophilus porphyriticus* in the Mus. Comp. Zoöl.; Hanover (Worthen 1891).

Massachusetts: Groton (Storer 1839). Based on a larva and very doubtful.

Connecticut: Canaan (Linsley 1844). This is a hearsay record.

In the absence of well authenticated specimens from New England these records may be disregarded.

New York: Indian Ladder, Albany Co. (Bishop 1923); Coxsackie (Baird 1852); White Plains (Deckert 1914); Vassar College (Smith 1882); Rossie, St. Lawrence Co. (Hough 1852); Onondaga Co. (Britcher 1903). The last two are somewhat doubtful records.

New Jersey: Hemlock Falls (Sherwood 1895); Hunterdon Co., and Gloucester, Camden Co. (Fowler 1908); New Brunswick (Crozier 1924).

Pennsylvania: Honesdale and Orson, Wayne Co.; Springville, Susquehanna Co.; Shickshinny, Luzerne Co.; Weissport, Carbon Co.; and Allentown, Lehigh Co. (Surface 1913); Nazareth, Northampton Co. (Weid 1865); Aineyville, Summit Lawn, and Vera Cruz, Lehigh Co. (Mattern 1917); Auburn, Schuylkill Co. (Surface 1913); Woodburne and Hulmsville, Bucks Co. (Fowler 1917); Buckingham, Richhill, and George School, Bucks Co., Rahns and Bryn Mawr, Montgomery Co. (Surface 1913); Fawkes Run, Delaware Co. (Fowler 1915); Swarthmore, Delaware Co., Hamburg, Loraine, Calcium, Robesonia, Reading and Kutztown, Berks Co., Danville, Montour Co., Onset, Annville and Myerstown, Lebanon Co., Dauphin, Rockville, Lichens, Progress, Middletown and Williamstown, Dauphin Co., Williamsport, Lycoming Co., Middleburg, Snyder Co., Marshrun and Marysville, Perry Co., Stewartstown, York Co., Enola and Mechanicsburg, Cumberland Co., Mont Alto and Marion, Franklin Co., Lemont and Bellefonte, Centre Co., Johnstown, Cambria Co., Warren, Warren Co., Indiana, Indiana Co., Waterford, Erie Co., Greenville, Mercer Co., Swissvale, Allegheny Co. (Surface 1913).

Delaware: Newark (Fowler 1925).

Maryland: Piney Cr., Conowingo (Fowler 1925).

Alabama: Madison Co., Etowah Co., and St. Clair Co. (Löding 1922); Saginaw, Shelby Co., and Sand Mt., Jackson Co. (Holt 1924).

North Carolina: Bridgewater (Bishop 1924).

Tennessee: Tyree Springs, Sumner Co. (Cope 1889).

Ohio: Columbus (Cope 1889); Fairfield Co. (Morse 1901); Licking Co. and Lorain Co. (Morse 1904).

Illinois: Aux Plaines River (Yarrow 1883); "throughout" (Davis and Rice 1883). The specimen (U. S. N. M. No. 9555) on which the Aux Plaines record was

based has disappeared and as neither specimens nor records are known from Indiana the Illinois records are highly dubious.

Wisconsin: Racine (Hoy 1883); "southern half" (Higley 1893). These also are very improbable.

Michigan: (Clark 1905). No specimens are known from Michigan and the state has been thoroughly worked.

Kansas: (Cragin 1881). This was based on an incorrect statement of the range in Jordan's Manual of Vertebrates.

Montana: Fort Benton (Yarrow 1883). Based on U. S. N. M. No. 1840, collected by Hayden. This is not now to be found and the record is undoubtedly incorrect.

PSEUDOTRITON RUBER NITIDUS DUNN

1895 *Spelerpes ruber montanus* Rhoads, Proc. Acad. Nat. Sci. Philadelphia, p. 401.

1912 *Spelerpes ruber* Brimley, Proc. Biol. Soc. Washington 25, p. 140.

1920 *Pseudotriton ruber nitidus* Dunn, Proc. Biol. Soc. Washington 33, p. 133; Stejneger and Barbour 1923, Check List (2), p. 15; Breder and Breder 1923, Zoölogica 4, p. 16.

Type: M. C. Z. No. 5649, adult female, collected July 11, 1919, by E. R. Dunn.

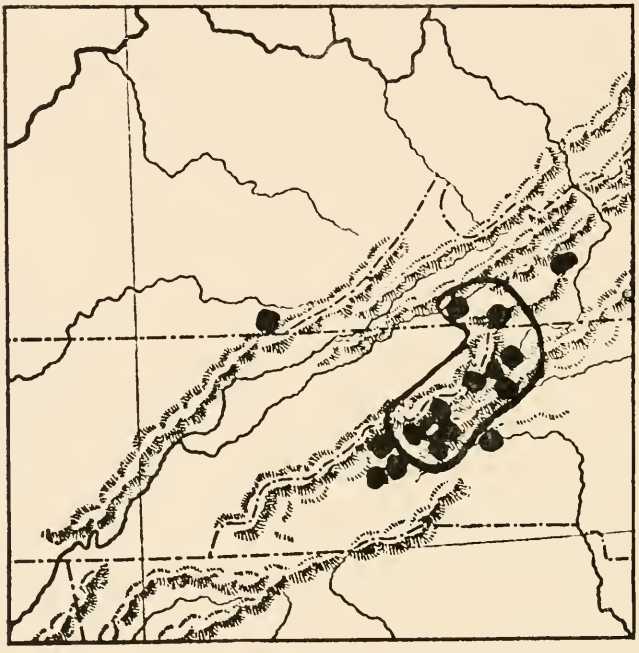
Type locality: White Top Mt., Va., 4,000 feet.

Range: Abingdon and White Top Mt., Va., south in the mountains to Old Fort, N. C. This form inhabits the northern half of the southern Blue Ridge. Reaches 4,200 feet on Grandfather Mt.

Diagnosis: Similar to *P. ruber ruber* but with no black pigment in distal half of tail, little or none on chin, and spots on dorsal surface not running together in adult.

Description: M. C. Z. No. 5649, adult female, 16 costal grooves; 6 costal folds between appressed toes; head width 5½ in distance from tip of snout to vent; head length 4 in length of body; head a broad oval from above; no canthus rostralis; eye as long as its distance from tip of snout; snout not swollen; outline of jaw straight as seen from side; angle of jaw back of hind angle of eye; hind part of lower eyelid with groove into which upper fits so that part of lower is prolonged backwards spur fashion; a groove along side of neck from eye to gular fold; a groove from this vertically down past angle of jaw; gular fold on sides of neck to dorsal surface; tail shorter than body, flattened at tip, a raised keel on dorsal surface; limbs well developed; fingers short 3, 2, 4, 1 in order of length; toes 3, 4, 2, 5, 1 in order of length; anal lips smooth; vomerine tooth series confluent with parasphenoid, forming a right angle and passing beyond outer

border of choanae, separated from each other by half the length of the short leg of the angle; red, lighter below, definite scattered black spots on top of head, on back, on top of proximal half of tail, and on upper surfaces of limbs; no markings on body or tail, ventral to a line joining insertions of legs; a few dots along lower lip and on throat; total length 97, head 12, body 49, tail 36.



41. Southern mountains, showing localities for Pseudotriton ruber nitidus (outlined), and nearest localities for P. r. ruber and P. r. schencki.

Variation: A male, A. N. S. 4782, Cranberry, N. C., differs as follows: five costal folds between appressed toes; head width 5 in length from snout to vent; head length 3¾ in body length; a ventral keel at tip of tail; anal lips lined with papillae; color similar but no dots on throat and very few on limbs, tail almost entirely unspotted; total length 84, head 12, body 42, tail 30. A larva, A. N. S. 4389, Roan

Mt., Tenn., 4,000 feet, very near transformation is chiefly noticeable for having a narrow dark mid-dorsal line; the absence of spots on the tail is marked; total length 68, head 9, body 35, tail 24.

Largest male seen	84	12	42	30	Cranberry, N. C.	A. N. S. 4782
Largest female seen	103	13.5	52.5	37	Cane R., N. C.	U. S. N. M. 31158
Largest larva seen	68	9	35	24	Roan Mt., Tenn.	A. N. S. 4389
Smallest adult seen	69.5	9	34	26.5	Abingdon, Va.	M. C. Z. 5647

Habits: Little or nothing has been published on this form. Rhoads (1895) mentions finding a larva in a spring 4,000 feet up on Roan Mt. He also mentions seeing a specimen "in a spring on the summit of Roan Mountain," but as this was not taken the identification is doubtful. Of my own specimens one was taken at the edge of a muddy spring outside of Abingdon (2,000 feet), and two under logs in woods in the oak-chestnut belt at 4,200 feet elevation on White Top and on Grandfather Mt.

Remarks: This appears the most primitive of the three races of *ruber*. Its general adult coloration is nearest that of the young of all three. Examples which intergrade with *schencki* to the south have been seen from Marshall, N. C., and with *ruber* to the east from Catawba Co., N. C.

Specimens seen 10, as follows:

Virginia: Abingdon 1 (M. C. Z. No. 5647); White Top Mt. 1 (M. C. Z. No. 5649 TYPE).

North Carolina: Beaver Creek, Ashe Co. 2 (Breder); Linville 1 (A. M. N. H. No. 4852); Cranberry 1 (A. N. S. No. 4782); Cane River 1 (U. S. N. M. No. 31158); Spruce Pine 1 (A. N. S.); Old Fort 1 (M. C. Z. No. 998).

Tennessee: Roan Mt. 1 (A. N. S.).

Brimley (1912) records it from Burnsville, N. C.

PSEUDOTRITON RUBER SCHENCKI (BRIMLEY)

1870 *Spelerpes ruber* Cope, Amer. Nat. 4, p. 400.

1900 *Spelerpes* sp. Blatchley, Report Geol. Indiana 25, p. 760.

1912 *Spelerpes ruber schencki* Brimley, Proc. Biol. Soc. Washington 25, p. 139, pl. 7, ff. 12-13, 15, 17-18, 20-22; Dunn 1917, Bull. Amer. Mus. Nat. Hist. 37, p. 613, f. 4, pl. 59, f. 5, pl. 60, f. 1.

1915 *Spelerpes schencki* Brimley, Journ. Elisha Mitchell Sci. Soc. 30, p. 6.

1917 *Eurycea rubra schencki* Stejneger and Barbour, Check List, p. 20.

1918 *Pseudotriton ruber schencki* Dunn, Bull. Mus. Comp. Zoöl. 62, p. 467; 1920, Proc. Biol. Soc. Washington 33, p. 133; Stejneger and Barbour, Check List (2), p. 15.

Type: U. S. N. M. No. 49679, collected by C. S. Brimley.

Type locality: Sunburst, Haywood Co., N. C. (Brimley in a recent letter says of this place that it is "the last station on the railway, now Spruce").

Range: From Asheville School (near Asheville, N. C.) to Ramhurst, Murray Co., Ga., and Tallulah Falls, Ga. Inhabits the more dissected southern half of the southern Blue Ridge. Reaches 3,500 feet in the Balsam Mts.

Diagnosis: Similar to *P. ruber ruber* but not so large, max. 125 mm., with spots not running together and chin black.

Description: M. C. Z. 2889, adult female, Sunburst, N. C., 16 costal grooves; 5½ costal folds between appressed toes; head width 6½ in length from tip of snout to vent; head length 3½ in length of body; head an oval; eye as long as its distance from tip of snout; snout flat, a faint canthus rostralis; outline of upper jaw straight as viewed from side; angle of jaw beneath hind angle of eye; hind part of lower eyelid with groove into which upper fits so that part of lower is prolonged backwards spur fashion; gular fold on side of neck to dorsal surface; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 2, 5, 1 in order of length, tail shorter than body, ovoid in cross section, a raised dorsal ridge throughout; anal lips smooth; vomerine and parasphenoid series continuous, beginning behind outer edge of nares, passing straight inwards, forming an obtuse angle and thence backwards, separated from its fellow by half the length of the short side; reddish, separated spots over dorsal surface of head, body, limbs and tail; coarser on back, finer on sides, ceasing at level of insertion of legs; few spots on mid-region of belly; sides and venter of throat well spotted; a black line from eye to nostril; edge of upper lip black; a broad black band around edge of lower lip; tips of toes and fingers black; total length 121, head 15, body 52, tail 44.

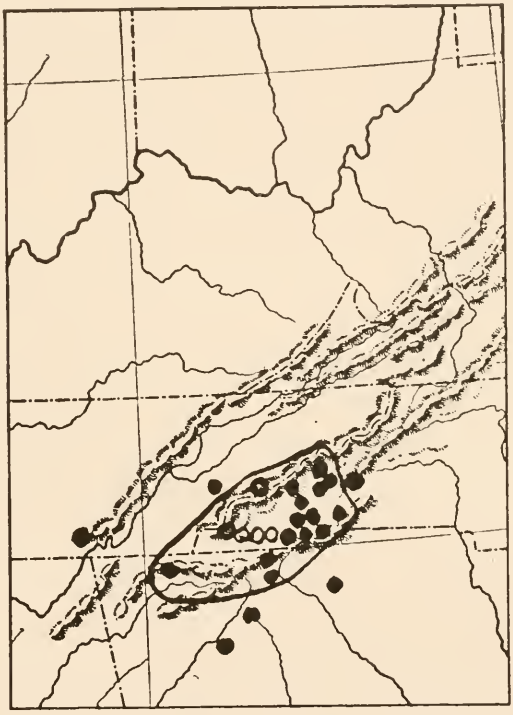
Variation: A male, M. C. Z. No. 7324; Asheville School, N. C., varies in having the head width 5⅓ in the length from tip of snout to vent; the head length about 4 in length of body; anal lips lined with papillae; vomerine series forming a right angle and the two series separated by the length of the short side; total length 87, head 12, body 46, tail 29. A larva, M. C. Z. No. 5650, from Mt. Sterling, N. C., has 5 costal folds between the appressed toes; upper series of larval areas a row of small unpigmented dots, about two to every three cos-

tal folds, lower series not evident; no pigment on chin or throat; total length 52, head 6.5, body 23.5, tail 22.

Very small specimens sometimes have the distal half of the tail unspotted.

Largest male	118	15	60	43	U. S. N. M. 38232	Blantyre, N. C.
Largest female	125	16	62	47	U. S. N. M. 52516	Pink Beds, N. C.
Largest larva	69	9	34	26	U. S. N. M. 57122	Buncombe Co., N. C.
Smallest adult	60	9	28	23	M. C. Z. 4490	Tallulah Falls, Ga.
Smallest larva	28				A. M. N. H.	Brevard, N. C.

Habits: Nothing has been published save my brief notes on those examples which I collected for the American Museum (Dunn 1917b). "Most of the adults and all of the larvae and transforming young



42. Southern mountains, showing localities for Pseudotriton ruber schencki (outlined), and nearest localities for ruber and nitidus.

were taken in swampy springs." One adult was found under a log "some distance from the water." They were "much less active and more easily caught than typical *ruber*. They seemed to be somewhat nocturnal, as several were caught wandering in the camp spring at night." Those taken in the transformation stage ranged from 57-72 mm. in length.

Remarks: I have seen intergrades with *nitidus* on the north and with *ruber* to the south. Specimens from Marshall, N. C., belong in the former category and some from Clayton, Rabun Co., Ga., in the second. Of the three races I believe *nitidus* to be the more primitive.

Blatchley (1900) and Cope (1870) both mention this form. Cope does not differentiate between it and *ruber* but Blatchley realized that he had a peculiar form.

Specimens seen 76, as follows:

Tennessee: No locality (probably Great Smoky Mts.) 1 (U. Mich. No. 42464).

North Carolina: Asheville School 1 (E. R. D.); Marshall 2 (A. M. N. H. No. 5277, 5281); Weaverville 2 (Cornell, larvae); Henderson Co. 1 (A. N. S. No. 663); Flat Rock 5 (A. M. N. H. No. 21190-4); Blantyre 2 (U. S. N. M. No. 38231-2); Brevard 24 (A. M. N. H. No. *4148*, *4154*, 4161-2, *4170*, *4189*, 4343, *4349*, *4355*, 4358, *4441*, 4458, *4460-1*, *4470*, *4495-6*, *4501*, 4506-8, 4514); Pisgah Forest Reserve 14 (U. Mich. No. 52516-26, A. M. N. H. No. 4386-7, *4439*); Highlands 6 (Cornell 6079, U. S. N. M. No. 36688-9, 38233-5); Sunburst 4 (Cornell No. 6080, M. C. Z. No. 2889, U. S. N. M. No. 49679 TYPE, 49680); Waynesville 2 (S. C., Chapin); Mt. Sterling 1 (M. C. Z. No. *5650*).

Georgia: Ramhurst, Murray Co. 1 (U. Ala.); Mt. City Gap 1 (Cornell No. 6360); Clayton 5 (Cornell 3, Davis 2); Tallulah Falls 1 (M. C. Z. No. 4490); no locality 3 (M. C. Z. No. 4491).

It has also been recorded from Andrews (Brimley 1912), Aquone, and Wayah Bald Mt., N. C. (Brimley 1915); Cullasaja, N. C. (Brimley in litt.); and from Sevier Co., Tenn. (Blatchley 1900).

PSEUDOTRITON MONTANUS MONTANUS (BAIRD)

1820? *Triturus hypoxanthus* Rafinesque, Ann. Nat., p. 4 (western Kentucky).

1849 *Pseudotriton montanus* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 293; Dunn 1918, Copeia 53, p. 19; 1918, Bull. Mus. Comp. Zoöl. 62, p. 466; 1920, Proc. Biol. Soc. Washington 33, p. 132; Brimley 1922, Copeia 109, p. 64 (habits); 1923, Copeia 120, p. 82 (habits); Brady 1924, Copeia 130, p. 54.

1923 *Pseudotriton montanus montanus* Stejneger and Barbour, Check List (2), p. 14; Myers 1924, Copeia 131, p. 59.
1850 *Spelerpes montana* Gray, Cat. Batr. Grad. Brit. Mus., p. 45.
1869 *Spelerpes ruber montanus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 107; Boulenger 1882, Cat. Bat. Grad. Brit. Mus. (2), p. 63; Cope 1889, Bull. U. S. Nat. Mus. 34, p. 129.
1884 *Geotriton rubra montanus* Garman, Bull. Essex Inst. 16, p. 39.
1917 *Spelerpes montanus* Brimley, Proc. Biol. Soc. Washington 30, p. 87; 1918, Journ. Elisha Mitchell Sci. Soc. 34, p. 149.
1917 *Eurycea montana* Stejneger and Barbour, Check List, p. 19.
1869 *Spelerpes ruber sticticeps* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 107 (Georgia); 1889, Bull. U. S. Nat. Mus. 34, p. 178.
1884 *Geotriton rubra sticticeps* Garman, Bull. Essex Inst. 16, p. 39.
1912 *Spelerpes ruber ruber* Brimley, Proc. Biol. Soc. Washington 25, pl. 7, ff. 14, 16, 19.

Type: U. S. N. M. Cat. No. 3839, collected by S. F. Baird.

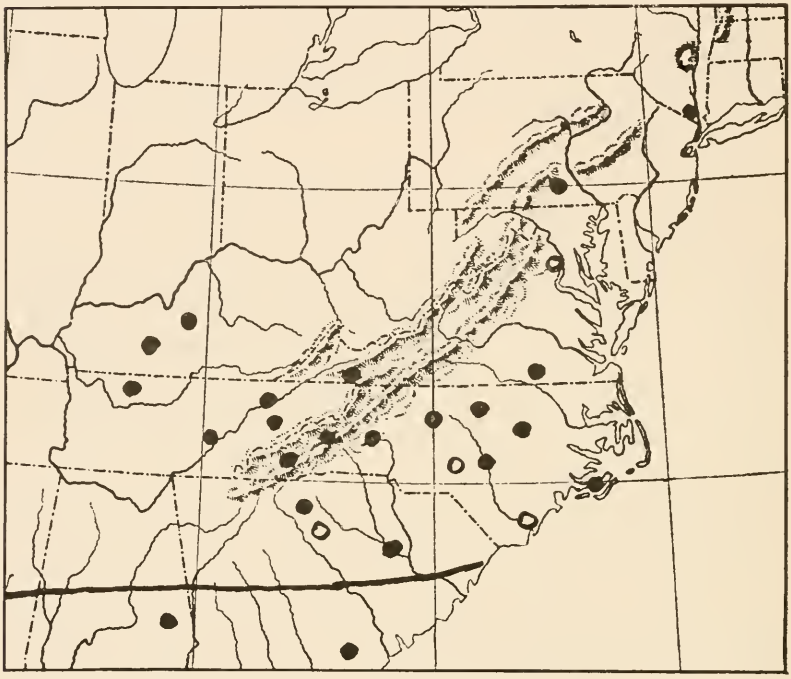
Type locality: South Mountain, near Carlisle, Pa.

Range: From Carlisle, Pa. (or from Orangeburgh, N. Y.), and Brunswick Co., Va., to Morganton, N. C., Beaufort, N. C., Columbia, S. C., Anderson, S. C., Tyree Springs, Tenn., Union Co., Tenn., Abingdon, Va., and Bee Spring, Ky. Range apparently discontinuous.

Diagnosis: A red salamander with dark ground color and few separated circular black spots; costal grooves 17; tooth rows close together; total length to 178 mm.

Description: M. C. Z. 5731, adult male, Raleigh, N. C.; costal grooves 17; 7 costal folds between appressed toes; head width 6½ in length from tip of snout to vent; head length 4½ in length of body; head a broad oval viewed from above; eye as long as its distance from tip of snout; snout not swollen; a slight swelling of upper lip below nostril; outline of upper jaw straight as viewed from side, turned down at angles; angle of jaw back of hind angle of eye; hind part of lower eyelid with groove into which upper fits so that part of lower is prolonged backwards spur fashion; a groove from eye backwards and downwards behind angle of jaw; back from this a groove laterally to gular fold; limbs short and stout; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 2, 5, 1 in order of length; tail shorter than head and body, tip flattened, keeled above in distal half; anus with lips lined with papillae; vomerine and parasphenoid series continuous, beginning behind outer edge of nares, curving inwards and back-

wards until they are separated by less than the width of the nares, at the middle of the eyesocket they diverge somewhat and are made up of more than one row of teeth; dark reddish brown above and on upper surfaces of limbs; at the level of the insertion of the limbs this color fades into the light reddish cream color of the under surface; a few circular black dots about the size of the iris on flanks and base



43. Eastern United States, showing localities for Pseudotriton montanus montanus (north of line), and nearest localities for P. m. flavissimus.

of tail, seven of these on the right side between the limbs, edge of lower jaw clouded; total length 178 mm., head 17, body 76, tail 85.

Variation: A female, M. C. Z. 5739, Raleigh, N. C., varies as follows: 8 costal folds between appressed toes; no swelling of upper jaw; anal lips without papillae; coloration somewhat darker; total length 173, head 18, body 81, tail 74.

A larva, M. C. Z. No. 5643, Spring City, Tenn., has 6 costal grooves between appressed toes (so does a young male from the same locality); head length 3½ in body length; tail shorter than body; color rather uniform dark above with small irregular flecks of black; no pigment on chin.

The adult varies considerably in density of ground color. This usually increases with age so that the black spots cannot be made out in certain specimens. The number of spots also varies from very few as in the described specimens to a considerable number in others. Yet they always retain their circular shape, remain distinct and are not so large as the spots of *ruber*. The dentition is quite constant. The tooth rows curve instead of the angle usual in *ruber* and as a rule do not pass beyond the outer border of the nares. They are always closely approximated. The proportions vary considerably. Length of head, length of tail, and distance between toes, while usually different from the same proportions in *ruber,* are not absolutely distinctive characters. Large larvae usually show a few black spots, thus resembling the adult in coloration.

Largest male seen	178	17	76	85	M. C. Z. 5731	Raleigh, N. C.
Largest female seen	176	18	84	74	M. C. Z. 5756	Raleigh, N. C.
Largest larva seen	68	8.5	40.5	19	Smith College	Raleigh, N. C.
Smallest adult seen	78	10	36	32	M. C. Z. 5772	Raleigh, N. C.
Smallest larva seen	34	5.5	18.5	11	Smith College	Raleigh, N. C.

Habits: Very little is known as to habits. I collected two at Abingdon, Va., in very muddy places under stones, or logs. One of these was in a burrow in the mud with his head out under a log. At Spring City, Tenn., I took a small adult under a log alongside a road in woods, perhaps 100 yards from water, on the side of a hill. I also got some larvae in a very muddy spring in the same vicinity.

Mr. C. S. Brimley has very kindly written me as follows concerning *montanus* at Raleigh, N. C.: "As to the habitat of the animal as compared with *ruber,* I should say it was decidedly more aquatic. I have found it not infrequently under dead logs in wet low grounds and under stones or rubbish in woodland brooks, *never* under logs or rubbish at any distance from water nor in any situation that could by any stretch of the imagination be called dry." "*Montanus* found under a log in wet ground will often be in proximity to a crayfish or other burrows, which it will readily go into, in water it endeavors to escape much as does *Desmognathus fusca* or *quadramaculata* by bur-

rowing under anything handy. At Raleigh I suppose *montanus* forms at least 90% of our red *Spelerpes*. I found some eggs recently that I take to be probably this species, unpigmented, but larger than those of *S. bislineatus*. They were found November 27th under matted dead leaves and débris at the bottom of a choked up ditch from a feeble spring." Mr. Brimley very kindly sent me some of these eggs. They measure 6 mm. in diameter, are single and stalked for attachment. The stalk is 4 mm. long.

He has published some further observations (1923) regarding the same locality: "On December 23, 1922 . . . one batch of eggs which were most probably those of *Pseudotriton montanus* were discovered in the runlet . . . as also two one year old larvae and an adult." "On February 1, 1923, I also found another lot of eggs in the runlet from the larger spring which I imagine to be *P. montanus* eggs, they were of course unpigmented, much larger than the *Manculus* eggs, and bunched much more in groups on the dead leaves lying in the water."

In regard to its food he says (1922): "I have known the species at Raleigh to disgorge when caught specimens of smaller salamanders, such as *Eurycea bislineata*. As a further clue to its habits I may add that two small adults were kept in an aquarium for about three months, and were as much at home in and under the water as newts, although specimens of *Eurycea guttolineata* and *Desmognathus fusca* drowned in a day or so."

Remarks: The closest relationship of this form is with *flavissimus* which is a degenerate, dwarfed race. Specimens from Beaufort, N. C., and Auburn, Ala., appear intermediate. I have classed the former with *montanus*, the latter with *flavissimus*. Relationship is not more with one race of *ruber* than with another unless the more distinct spotting of the mountain forms be proof of kin.

This animal has been either neglected or wrongly treated in most of the literature. As a rule the name has been either ignored or else has served as a sort of scrap-basket to hold aberrant specimens of *ruber*. Even now its range is imperfectly known. Much of the work in anatomical papers on "*ruber*" really refers to *montanus* because one of the chief sources of *ruber* for laboratory material formerly included many specimens of *montanus*.

Specimens seen 158, as follows:

New York: Orangeburgh 1 (A. M. N. H. No. 1701).

Pennsylvania: Carlisle 3 (U. S. N. M. No. 3839 TYPES).
Virginia: Crichton 1 (U. S. N. M. No. 5949); Abingdon 2 (M. C. Z. No. 5646).
North Carolina: Raleigh 113 (M. C. Z. No. 5680-773, U. S. N. M. No. 16631, 22174, 38236-7, 49681, 51182-5, A. M. N. H. No. 628, 2521, 5377, S. C.; Salem 2 (U. S. N. M. No. 3848); Morganton 1 (U. S. N. M. No. 9120); Hillsboro 2 (U. S. N. M. No. 7031); Summerville 2 (U. S. N. M. No. 3844); Beaufort 2 (M. C. Z. No. 997, U. S. N. M. No. 5948); Asheville 1 (Carnegie No. 2900); Flat Rock 11 (A. M. N. H. No. 21010, 21178-83).
South Carolina: Anderson 4 (U. S. N. M. No. 3873); Columbia 1 (U. S. N. M. No. 16799).
Georgia: No locality 2 (U. S. N. M. No. 11475, TYPES of *sticticeps*).
Tennessee: Knoxville 1 (M. C. Z. No. 224); Tyree Springs, Sumner Co. 2 (U. S. N. M. No. 3870); Spring City 3 (M. C. Z. No. 5643-5); Matlock Springs, near Athens 1 (U. S. N. M. No. *21142*); Union Co. 1 (U. S. N. M. No. 8834).
Kentucky: Edmonson Co. 1 (M. C. Z. No. 5639); Willow Tree Spring, Nelson Co. 1 (N. Y. Mus.).

It has also been recorded from Mount Vernon, Va. (Brady 1924); Aberdeen, Moore Co., N. C. (Brimley 1922); Wilmington, N. C. (Myers 1924); and Abbeville, S. C. (Cope 1889).

PSEUDOTRITON MONTANUS FLAVISSIMUS (HALLOWELL)

1856 *Pseudotriton flavissimus* Hallowell, Proc. Acad. Nat. Sci. Philadelphia, p. 130.
1889 *Spelerpes ruber flavissimus* Cope, Bull. U. S. Nat. Mus. 34, p. 176.
1900 *Spelerpes ruber* Beyer, Proc. Louisiana Soc. Nat. 1897-1899, p. 10.
1922 *Eurycea montana flavissima* Löding, Alabama Mus. Nat. Hist. Paper 5, p. 14.
1923 *Pseudotriton montanus flavissimus* Stejneger and Barbour, Check List (2), p. 14.

Type: A. N. S. 576, collected by Major Le Conte.

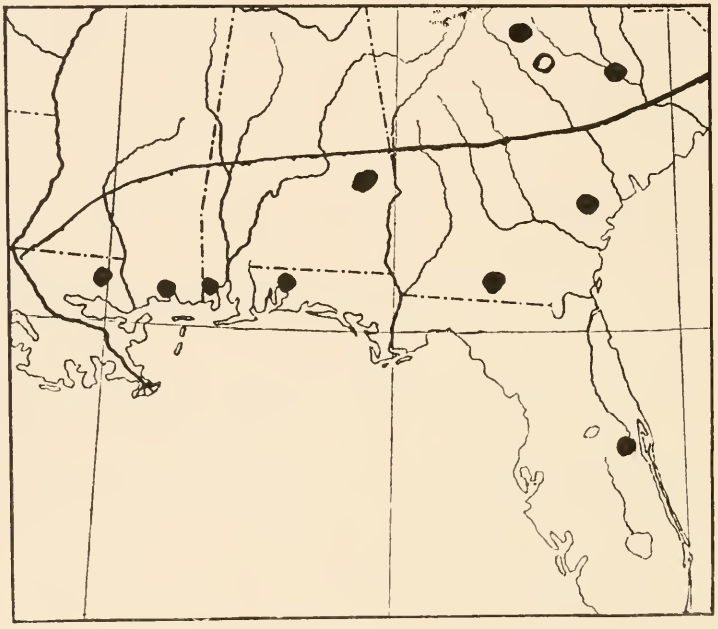
Type locality: Liberty Co., Georgia.

Range: From Liberty Co., Georgia to Chuluota, Fla., and Louisiana. Occupies the Coastal Plain.

Diagnosis: Similar to *P. montanus montanus* in color and dentition but smaller and with shorter tail. Reaches 105 mm.

Description: U. S. N. M. 51154, young male; Biloxi, Miss.; 16 costal grooves; 5 costal interspaces between appressed toes; head width 6½ in length from tip of snout to vent; head length 3½ in length of body; head oval from above; eye as long as its distance from tip of snout; snout not swollen; a slight swelling of upper lip below nostril; outline of upper jaw concave as seen from side, angle back of hind angle of eye; hind part of lower eyelid with groove into

which upper fits so that part of lower is prolonged backwards spur fashion; a groove from eye back on sides of neck to gular fold; a vertical groove behind angle of jaw crossing groove from eye; fingers 3, 2, 4, 1 in order of length; toes 3, 4, 2, 5, 1 in order of length; tail shorter than body, much flattened distally and keeled above and below; anal lips lined with papillae; vomerine and parasphenoid series continuous, beginning behind outer edge of nares, passing straight



44. Southeastern States, showing localities for Pseudotriton montanus flavissimus (south of line) and nearest localities for P. m. montanus.

in till separated by less than half width of nares, then making a right angle and continuing close together as a double row of teeth till opposite middle of eyesocket where they thicken and diverge somewhat; brownish above, light cream color below a line above insertions of legs, small scattered circular black spots above and on the sides and throat; total length 80, head 10, body 36, tail 34.

Variation: A female, U. S. N. M. 51153, same locality, has 7 costal

folds between the appressed toes; head width 6 in length from tip of snout to vent; head length 4½ in length of body; tail not keeled below; anal lips smooth; vomerine series making an obtuse angle; small black spots on belly; total length 99, head 11, body 49, tail 39. No larvae have been seen. Three Florida specimens have 18 costal grooves and 8 costal folds between appressed toes.

The tail may be slightly longer than the body. The distance between the appressed toes varies very much, from five in the specimen described above to nine in A. M. N. H. No. 6383 from Valdosta, Ga., which has 18 costal grooves. The other proportions, the dentition, and the coloration, are quite constant.

The largest and smallest specimens:

Sex	*Total*	*Head*	*Body*	*Tail*		
♂	105	10.5	52.5	42	Chuluota, Fla.	U. S. N. M. No. 22819
♀	103	10	45	48	Milton, Fla.	U. S. N. M. No. 11961
yg.	75	9.5	36.5	29	Mobile Co., Ala.	U. S. N. M. No. 57190

Remarks: From the coloration, the habitus, and the dentition this form seems to be a dwarf race of *montanus*.

Specimens seen 15, as follows:

Georgia: Liberty Co. 1 (A. N. S. No. 576 TYPE); Valdosta 1 (A. M. N. H. No. 6383).
Florida: Chuluota 1 (U. S. N. M. No. 22819); Milton 2 (U. S. N. M. No. 11691).
Alabama: Auburn 1 (A. N. S. No. 14692); Mobile Co. 4 (U. S. N. M. No. 57187-90).
Mississippi: Biloxi 4 (U. S. N. M. No. 51152-5).
Louisiana: 10 miles west of Bogalusa 1 (Viosca).

Various southern and western records for *ruber*: Indian Key, Fla. (Cope 1889); Prairie Mer Rouge, La. (Cope 1889); St. Tammany, and N. W. Louisiana (Beyer 1900); Fort Towson, Ark. [Okla.?]. (Cope 1889); in so far as correct doubtless refer to *flavissimus*.

EURYCEA RAFINESQUE

1822 *Eurycea* Rafinesque, Kentucky Gazette, N. S. 1, 9, p. 3 (type *lucifuga*).
1832 *Spelerpes* Rafinesque, Atlantic Journ. 1, p. 22 (type *lucifuga*).
1838 *Cylindrosoma* Tschudi, Mem. Soc. Sci. Nat. Neuchatel, p. 58 (type *longicauda*).
1843 *Saurocercus* Fitzinger, Syst. Rept., p. 34 (type *longicauda*).
1869 *Manculus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 95 (type *quadridigitata*).

Diagnosis: Tongue free all round; one premaxilla, nasal spines fused or not, a fontanelle; a septomaxilla; maxilla normal; prefrontals present, not bordering nares; internal nares a notch in prevomer; vomerine and parasphenoid series not continuous; condyles sessile; atlas normal; eyes functional; gills of larva with long rami; 3-4 epibranchials; male with swollen snout, sometimes with cirri and premaxillary fangs; tail not constricted at base; toes 4-5, or 4-4, free; terminal phalanges T-shaped; no palmar tubercles; ten forms.

Range: New Brunswick to New Mexico. Absent from southern Florida, and from Michigan, northern Illinois, and north of the Missouri River. Only one record for west of Texas, Oklahoma, and Kansas.

Key to adults of *Eurycea*.

A. Toes 5.
  B. Color red, not striped, 15 costal grooves, Middle West *lucifuga* 338
  B B. Color yellow.
    C. 13-14 costal grooves, larger, tail longer.
      D. A black mid-dorsal stripe, Southeast . . *gutto-lineata* 327
      D D. No black mid-dorsal stripe.
        E. Mid-dorsal line unspotted, no bars on tail, Ozarks . . . . . *melanopleura* 316
        E E. Mid-dorsal line spotted, bars on tail, Middle West . . . . . *longicauda* 320
    C C. 14-20 costal grooves, smaller, tail shorter.
      D. 14-15 costal grooves.
        E. Male without cirri, markings less definite, 15 costal grooves, Northeast . . . . . *bislineata* 295
        E E. Male with cirri, markings more definite, 14 costal grooves.

F. Dorso-lateral stripe broken up on tail, Southern Blue Ridge . . . . . *wilderae* 310

F F. Dorso-lateral stripe not broken up on tail, Southeast . . . . . *cirrigera* 307

D D. 20 costal grooves, Ozarks and West . . *multiplicata* 313

A A. Toes 4.

B. Yellowish, a dark dorso-lateral stripe . . . *quadridigitata* 331

B B. Darker, no definite markings . . . . . *remifera* 336

EURYCEA BISLINEATA BISLINEATA (GREEN)

1818 *Salamandra bislineata* Green, Journ. Acad. Nat. Sci. Philadelphia 1, p. 352; Thompson 1842, Hist. Vermont, p. 119; Fogg 1862, Proc. Portland Soc. Nat. Hist. 1, p. 86.

1826 *Salamandra bis-lineata* Harlan, Journ. Acad. Nat. Sci. Philadelphia 5, p. 332.

1838 *Pseudotriton ? bilineata* Tschudi, Mém. Soc. Sci. Nat. Neuchâtel, p. 60.

1838 *Salamandra bilineata* Holbrook, N. Amer. Herp. 2, p. 127, pl. 30; 1842, id. (2), 5, p. 55, pl. 16; DeKay 1842, Zoöl. New York 3, p. 79, pl. 23, f. 67; Linsley 1844, Amer. Journ. Sci. Arts 46, p. 49.

1849 *Spelerpes bilineata* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 287; Gray 1850, Cat. Batr. Grad. Brit. Mus., p. 21; Allen 1868, Proc. Boston Soc. Nat. Hist., p. 200.

1854 *Bolitoglossa bilineata* Duméril and Bibron, Erp. Gén. 9, p. 91.

1856 *Spelerpes bilineata* Hallowell, Proc. Acad. Nat. Sci. Philadelphia, p. 11; 1858, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 346.

1856 *Spelerpes (Cylindrosoma) bilineata* Hallowell, Proc. Acad. Nat. Sci. Philadelphia, p. 101.

1863 *Spelerpes bilineatus* Verrill, Proc. Boston Soc. Nat. Hist. 9, p. 199; Abbott 1868, Geol. Surv. New Jersey, p. 803; Cope 1869, Proc. Acad. Nat. Sci. Philadelphia, p. 107; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 66; Bicknell 1882, Trans. Linn. Soc. New York 1, p. 124; Smith 1882, Rept. Amph. Ohio, p. 727; Davis and Rice 1883, Bull. Chicago Acad. Sci. 1, 3, p. 27; Hoy 1883, Geol. Wisconsin 1, p. 426; Davis 1884, Proc. Nat. Sci. Ass. Staten I. 1, p. 13; Hughes 1886, Bull. Brookville Soc. Nat. Hist. 2, p. 44; Fisher 1887, Amer. Nat. 21, p. 672; Hay 1887, Journ. Cincinnati Soc. Nat. Hist. 10, p. 61; Butler 1888, Journ. Cincinnati Soc. Nat. Hist. 10, p. 147; Cope 1889, Bull. U. S. Nat. Mus. 34, p. 163, f. 40, pl. 28, ff. 4-6; Worthen 1891, Vert. Hanover, N. H., p. 61; Boettger 1892, Kat. Batr. Mus. Senckenbergianum, p. 60; Higley 1893, Wisconsin Acad. Sci. Arts 7, p. 172; Gaines 1895, Amer. Nat. 29, p. 55; Kingsbury 1895, Proc. Amer. Micr. Soc. 17, p. 282 (spermatheca); Sherwood 1895, Proc. Linn. Soc. New York 7, p. 31; Wilder 1896, Anat. Anz. 12, p. 183; Cox 1898, Bull. Nat. Hist. Soc. New Brunswick 16, 4, 1, p. 65; Mearns 1898, Bull. Amer. Mus. Nat. Hist. 10, p. 303; Allen 1899, Proc. Boston Soc. Nat. Hist. 29, p. 75; Blatchley 1899, Rept. Geol. Indiana, p. 540; Mearns 1899, Proc. U. S. Nat. Mus. 21, p. 345;

Wilder 1899, Amer. Nat. 33, p. 231 (habits); Bowers 1900, Proc. Amer. Acad. 36, p. 179 (cranial nerves); Moore 1900, Proc. Acad. Nat. Sci. Philadelphia, p. 620 (vertebrae); Morse 1901, Ohio Nat. 1, p. 115; Britcher 1903, Proc. Onondaga Acad. Sci. 1, p. 120; Morse 1904, Proc. Ohio Acad. Sci. 4, p. 113; Henshaw 1904, Occ. Pap. Boston Soc. Nat. Hist. 7, 2, p. 4; Drowne 1905, Mon. 15, Roger Williams Park Mus., p. 18; Stone 1906, Amer. Nat. 40, p. 161; Banta and McAtee 1906, Proc. U. S. Nat. Mus. 30, p. 80 (larva); Whipple 1906, Biol. Bull. 10, p. 357 (ypsiloid); 1906, Biol. Bull. 11, p. 1 (naso-labial groove); Kingsbury and Reed 1908, Anat. Rec. 2, p. 82 (otic apparatus); Doolittle 1908, U. S. Fish Comm. Doc. 633, p. 75; Goodale 1911, Amer. Journ. Anat. 12, p. 173 (embryology); Banta and Gortner 1913, Ohio Nat. 13, p. 49 (pigmentation); Surface 1913, Zoöl. Bull. Pennsylvania Dept. Agric. 3, 3-4, p. 98, f. 10; Deckert 1914, Copeia 13; Reed 1914, Anat. Rec. 8, p. 113 (otic apparatus); Chapin 1915, Biol. Bull. 29, p. 129 (hermaphroditism); Banta and Gortner 1915, Proc. U. S. Nat. Mus. 49, p. 377, pl. 54-5 (albinism); Higgins 1921, Illinois Biol. Mon. 6, 1, p. 25 (nasal capsule); Emmel 1924, Amer. Journ. Anat. 33, p. 351, pl. 1, ff. 10-12 (erythrocytes).

1884 *Geotriton bilineata* Garman, Bull. Essex Inst. 16, p. 39.

1892 *Spelerpes bislineatus* Hay, Rept. Geol. Indiana, p. 448; Rhoads 1895, Proc. Acad. Nat. Sci. Philadelphia, p. 401; Hay 1902, Proc. Biol. Soc. Washington 15, p. 125; Clark 1905, Rept. Michigan Acad. Sci. 7, p. 110; Fowler 1907, Rept. New Jersey Mus. 1906, p. 63, pl. 12; McAtee 1907, Proc. Biol. Soc. Washington 20, p. 15; Kingsbury and Reed 1908, Journ. Morph. 20, p. 577 (otic apparatus); Fowler 1908, Rept. New Jersey Mus., p. 394; Hahn 1908, Proc. U. S. Nat. Mus. 35, p. 556; Reed and Wright 1909, Proc. Amer. Phil. Soc. 48, p. 405; Keim 1914, Copeia 2; Street 1914, Copeia 4; Dunn 1915, Copeia 16; 1915, id. 25, p. 63; Fowler 1915, Proc. Delaware Co. Inst. Sci. 7, 2, p. 8; 1915, Copeia 22, p. 38; Keim 1915, Copeia 24, p. 51; Dunn 1916, Copeia 28, p. 22; 1917, Proc. U. S. Nat. Mus. 53, p. 415; Fowler 1917, Copeia 40, p. 14; Evermann and Clark 1917, Proc. Indiana Acad. Sci. 1916, p. 507; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 20; Mattern 1917, Copeia 46, p. 64; Reed 1920, Journ. Morph. 33, p. 327 (otic apparatus); Smith 1920, Journ. Morph. 33, p. 527 (branchial arches); Wilder 1920, Anat. Rec. 17, p. 349 (prevomer); Gutman 1923, Anat. Rec. 26, p. 373 (metamorphosis); Edgeworth 1925, Journ. Anat. 59, p. 228 (chrondocranium).

1917 *Eurycea bislineata* Stejneger and Barbour, Check List, p. 18; Patch 1917, Ottawa Nat. 32, p. 53; Dunn 1918, Copeia 53, p. 19; 1918, Bull. Mus. Comp. Zoöl. 62, p. 470; Evermann 1918, Copeia 56, p. 50; 1918, id. 61, p. 83; Speck 1919, Copeia 70, p. 48; Wright and Moesel 1919, Copeia 72, p. 64; Bishop 1923, Copeia 118, p. 67; Wilder 1924, Amer. Nat. 58, p. 538, ff. 1, 3 (premaxilla); 1924, Copeia 133, p. 77 (habits); 1924, Journ. Exper, Zoöl. 40, p. 1 (life history); Wilder and Peabody 1924, Biol. Bull. 47, p. 345 (hermaphroditism); Fowler 1925, Copeia 145, p. 58; Koehring 1925, Biol. Bull. 49, p. 250 (spermatheca); Humphrey 1925, Journ. Morph. 41, p. 12 (germ cells).

1920 *Eurycea bislineata bislineata* Dunn, Proc. Biol. Soc. Washington 33, p. 134;

Stejneger and Barbour 1923, Check List (2), p. 15; Brady 1924, Copeia 130, p. 55; Bishop 1925, Copeia 139, p. 11.

1826 *Salamandra flavissima* Harlan, Amer. Journ. Sci. Arts 10, p. 286 (Pennsylvania); 1826, Journ. Acad. Nat. Sci. Philadelphia 5, p. 332.

1840 *Salamandra haldemanni* Holbrook, N. Amer. Herp. 4, p. 125, pl. 28 (Susquehanna R., Pa.); 1842, N. Amer. Herp. (2), 5, p. 59, pl. 18.

1850 *Ambystoma haldemanni* ? Gray, Cat. Batr. Grad. Brit. Mus., p. 38.

1854 *Triton haldemanni* Duméril and Bibron, Erp. Gén. 9, p. 156.

1858 *Spelerpes haldemanni* Hallowell, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 347; Cope 1859, Proc. Acad. Nat. Sci. Philadelphia, p. 124; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 60.

1854 *Salamandra dorsata* Valenciennes in Duméril and Bibron, Erp. Gén. 9, p. 93.

1854 *Salamandra bitaeniata* Valenciennes in Duméril and Bibron, Erp. Gén. 9, p. 93.

1865 *Desmognathus fuscus* Verrill, Proc. Boston Soc. Nat. Hist. 9, p. 253 (habits); Cox ? 1899, Trans. Roy. Soc. Canada (2), 5, p. 141; ? 1899, Ottawa Nat. 13, p. 194; Hawkinson ? 1915, Bull. Illinois Lab. Nat. Hist. 11, 3.

1889 *Spelerpes bilineatus borealis* Cope, Bull. U. S. Nat. Mus. 34, p. 165 (Lake Oquassa, Me.); Cox 1898, Bull. Nat. Hist. Soc. New Brunswick 16, 4, 1, p. 65.

1894 *Desmognathus ochrophaea* Wilder, Anat. Anz. 9, p. 216 (lunglessness).

1914 *Spelerpes* sp., Kendall, U. S. Bur. Fish. Doc. 783, p. 88.

Type: Not positively known to exist. Cope (1889) claims that U. S. N. M. No. 3738 from western Pennsylvania, collected by Green, are the types. Fowler and Dunn (1917) state that A. N. S. No. 695-8, no locality, collected by Dr. Bache, are the types. Probably there are none in existence and never were any. Cope states on another page that Green's types were from New Jersey.

Type locality: None given.

Range: From Godbout, P. Q., and York Co., New Brunswick, to Ottawa, Canada; Sandusky, Ohio; Lafayette, Indiana; Spring City, Tenn.; and Midway, Va. Replaced in southern Blue Ridge and in Southern States by other races.

Diagnosis: A *Eurycea* with 15 costal grooves, yellow ground color, 5 toes, pigment in two dorsolateral stripes which extend on tail, male without cirri or premaxillary fangs.

Description: M. C. Z. No. 4511, adult male; Woodstock, Vt.; costal grooves 15; 3 costal folds between appressed toes; head width 6½ in length from tip of snout to vent; head length 4 in length of body; head a broad oval; eye longer than its distance from tip of snout; snout swollen; a slight swelling of upper lip below nostril; outline of upper jaw convex as seen from side; angle of jaw forward of

hind angle of eye; hind part of lower eyelid with groove into which upper fits so that part of lower projects backwards spur fashion; a groove from lower eyelid to lip; a groove from eye back on sides of neck to gular fold; fingers 3, 2, 4, 1 in order of length; toes long, 3, 4, 2, 5, 1 in order of length, tail longer than head and body, a flattened oval in cross section, keeled above throughout; anal lips lined with papillae; vomerine teeth not connected with parasphenoids, 6-7 in

45. Eastern North America, showing localities for Eurycea bislineata bislineata.

series, beginning at inner posterior corner of nares, curving in and back and nearly meeting, separated from parasphenoids by their own length; latter in two patches beginning opposite hind edge of eye-socket; yellowish, a dark line from eye back on each side to tip of tail; between these a few irregularly placed dots on back; below these minute gray mottling to level of insertion of legs; this is darker on the tail and distally is indistinguishable from the dorsolateral stripe;

legs mottled above similar to sides; lower surface, mid-dorsal surface of tail, and snout immaculate; total length 87, head 8.5, body 34.5, tail 44.

Variation: Female, M. C. Z. No. 7347, Alexandria, Va., differs as follows: 4 costal folds between appressed toes; head width 7 in length from snout to vent; snout less swollen; tail keeled above and below throughout; anal lips smooth; total length 90, head 8, body 33, tail 49. Larva, M. C. Z. 4571, Berkshire, N. Y., has 3 costal folds between the appressed toes; is pigmented on the dorsal surface and the sides; pigment rather even but marked by rows of unpigmented areas. (Typically there are three of these (see Banta and McAtee 1906) an upper row on the sides of the back, a middle row in continuation of a line drawn from the eye, and a lower row between the insertions of the legs. These rows vary in different species and their fate and the accumulation of pigment around them determine the adult coloration). Upper rows can just be made out, quite large, less than one to every other costal fold; strong pigmentation on all sides save the median, where they tend to coalesce with the areas of the opposite side; middle series indistinct, about one to a costal fold; lower series very indistinct, scarcely marked off from the unpigmented ventral region, about one to a costal fold; total length 48, head 5, body 18, tail 15.

Largest male seen	115	10	42	63	E. R. D.	Ottawa, Can.
Largest female seen	105	9	39	37	E. R. D.	Do
Smallest adult seen	47	5	22	20	U. S. N. M. No. 26497	Do
Largest larva seen	68	6	26	36	E. R. Dunn	Clarke Co., Va.
Smallest larva seen	16	2.5	7.5	6	E. R. Dunn	Alexandria, Va.

Habits: Surface (1913) reports on the food in 18 stomachs, "spiders, mites, thousand-legged 'worms,' undetermined insects, Hemiptera, Homoptera, flies, beetles and their larvae, Rove beetles or Staphylinidae, Chalcis flies, and an undetermined salamander." Hahn (1908) at Mitchell, Indiana, says, "Amphipods were found in the stomach of an adult of this species, which was found on a rock at the edge of the stream where these crustaceans were abundant. Small diptera were also found in their stomachs." Ditmars (1905) in a paragraph on which I cannot improve says, "It is usually found hiding under flat stones in the beds of brooks, not actually under water, but where the soil is thoroughly saturated with moisture. When disturbed in its

hiding places, it does not entirely depend upon diminutive limbs for escaping from danger, but makes surprisingly rapid progress by doubling its body into a series of lateral undulations and suddenly straightening it. The result is a number of bewildering jumps. This performance is varied with a snake-like wriggling. Thus, with a combination of agile motions, the little animal makes like a flash for the water and secretes itself among the stones. It is seldom seen except in the immediate vicinity of water." This refers to the vicinity of New York City. McAtee, 1907, in Monroe Co., Indiana, says, "In November they come out of the water and pass the winter under stones and logs near the stream." On the contrary in Massachusetts they may be found the winter through in places where the water does not freeze and even moving about under the ice among the stones of brooks. The larvae are found on the bottom of shallow pools in brooks often hiding under small stones. As they spend about two years in the larval stage they may be taken at all seasons. Verrill (1862) was the first to record eggs of this species but he recorded them under the name of *Desmognathus fusca.*

H. H. Wilder (1900) has published an account of the life history. He says, "The eggs . . . may be obtained during May and June." This is for western Massachusetts. "I have found them at the following dates May 27, June 12. They are deposited in a single layer upon the lower side of submerged stones, each batch containing from 30-50 eggs. The stones which are suitable for this purpose must be in the form of an arch allowing the water to flow beneath." "They are generally in the more rapidly flowing portions of the brook, but the depth of water must be such that the eggs are at all times entirely submerged, as the lash of the surface ripples striking against them would subject them to mechanical injury. The eggs appear attached to the surface of the stone by gelatinous threads proceeding from the outer envelope, and although they are generally contiguous they are each attached separately." Development in the egg lasted from 15 to 20 days.

Mrs. Wilder has published an exhaustive account of the animal up to and including metamorphosis, based on collections numbering about 2,500 individuals from a single locality, "Bear's Den Brook, on Mr. Toby, in Sunderland, Mass." In Copeia 133, 1924, "a fairly

complete history of the species from egg-laying to transformation has been formulated and is here given in brief.

"Of the mating habits all that can be said is that the fertilization is internal, spermatozoa being received into the spermatheca of the female. Whether or not this is a direct transfer from the male cloaca is not known to us, since we have not as yet succeeded in inducing mating in captivity.

"Egg-laying occurs mainly in May [an early date is May 7, 1921], although we have found eggs in early stages of development during the first week in June. The eggs are fastened singly by a slender stalk of jelly to the under side of a stone beneath the water. Usually the water appears to be running freely with considerable rapidity under the stone but we have occasionally found batches of eggs on the under side of stones which were wedged down into the mud and gravel near the edge of the stream.

"The number of eggs in a batch varies from 12 to 36, the average being about 18, a relatively small number in comparison with reports from other localities but consistent with the numbers of large ova which we find in the ovaries of gravid females in this region.

"Hatching occurs about one month after the eggs are laid and is therefore in progress during June and the early part of July. The newly hatched individuals measure about 14 mm. in length and have still a supply of yolk which furnishes the basis for their growth and development for some two weeks after hatching (*postembryonic* period), during which time the digestive tract completes its differentiation and the mouth opening is formed. This period is a quiescent one, probably spent lying in hollows on the bottom, protected from the currents of water; for, although the newly hatched individuals swim actively against a current, when left undisturbed they quickly settle down to the bottom and remain quiet.

"By early August the young larvae, now thrown on their own resources for obtaining food, begin to distribute themselves in the brook and to appear in representative collections in constantly increasing numbers. By October they form about 72% of a representative collection but by the following spring have fallen to about 40%, indicating a heavy death rate during the winter.

"When the larvae are approximately a year old they have attained an average length of about 33 mm., although they show a large range

of variation in size. It is at this time that the majority of them begin to show structural changes looking toward metamorphosis, the most conspicuous one being the formation of the open grooves which will later close to form the naso-lacrimal ducts. Unlike most amphibians, however, these metamorphic changes progress slowly and are accompanied by continued growth, and thus cold weather comes on again before transformation has been attained. The majority pass through this second winter in a condition which may be designated *premetamorphic,* many indeed not having passed beyond the *incipient phase* of premetamorphosis, in which the naso-lacrimal grooves are still open. A small proportion have not even reached this incipient phase and thus appear in the collections of the following spring as typical larvae at a time when the majority of individuals of their own age (two years) are passing through the final metamorphic changes culminating in transformation.

"Transformation begins as early as May and reaches its height during July, continuing, however, during the summer and early fall. The laggard individuals do not achieve transformation during this period, and after passing through a third winter and when nearly three years old, undergo transformation simultaneously with the majority of the next younger set of individuals.

"Transforming individuals thus range in age from two to three years, while in length they range from 43 to 76 mm., and in weight from 400 to 1,100 mg. There is no apparent correlation between the larger size and the greater age at metamorphosis, since the apparently less successful individuals are the ones in which metamorphosis is longest delayed, and experimentally at least, such individuals do not usually attain the normal average size at transformation.

"The largest metamorphic individual of the collection (76 mm.) was a female, and in any collection the few individuals of very large size are more often female than male. There are not enough of these, however, to raise perceptibly the average length of transforming females above that of the males, the average length for each sex being 52.5 mm.

"From this account it becomes evident that any representative collection of so-called larvae comprises individuals of ages ranging from a year or younger to two and three years and in stages of development

ranging from the typical larval through the greatly prolonged pre-metamorphic and metamorphic to transforming individuals.

"In *Eurycea bislineata* we see some factor in operation which causes growth to continue for a period of a year or more after the inauguration of the structural changes leading to metamorphosis. Moreover, the gonads show a considerable range of variation in their developmental condition at transformation, although they have thus far always been found to be still immature. It would seem only a step farther in the operation of this delaying factor in metamorphosis to bring about true neoteny."

Koehring (1925) says, "the mating of *Eurycea* takes place in the spring. There have been no spermatozoa found in the spermatheca during the fall and winter months. April may be taken as the average mating season though there must be as variable a season for mating as there is for egg-laying, and many early and late dates have been recorded for *Eurycea* eggs."

Some experiments carried on at Harvard in 1920 show that the adults are thigmotactic and negatively phototropic; but if these stimuli are opposed one to the other, the negative reaction to light is much stronger than the thigmotactic response.

Remarks: Of the three races of this species those with 14 costal grooves *(wilderae* and *cirrigera)* are more primitive in this particular than is *bislineata* with 15 costal grooves. On the other hand the sexual dimorphism of the two former is certainly not primitive. *Cirrigera* has the longest vomerine series and in this character it is closer to the other forms of the genus than are the two northern forms. In coloration *wilderae* is somewhat more akin to the other species. In brief no one of the three is directly ancestral to the others and the forms probably developed more or less in situ. Intergrades between *cirrigera* and *wilderae* have been seen from Rome, Ga. Intergrades between *cirrigera* and *bislineata* from Midway, Va., and Gloucester, Va., have 14 costal grooves, are intermediate in color and lack the cirri. I have recorded them with *bislineata* and the same applies to specimens from Spring City, Tenn. Abingdon, Va., examples while approaching *wilderae* are on the whole best considered as *bislineata.*

The species as a whole has more affinities with *multiplicata* than with any of the other members of the genus. That form, however, has an excessively elongated body, the pattern is rather obscure and it is

at present as abundantly distinct in anatomical character as it is distant in range.

The present race was one of the earliest described of North American salamanders and is common throughout its range. Together with *Desmognathus fuscus fuscus* and *Plethodon cinereus* it has been much studied.

Salamandra haldemanni Holbrook is based on a transforming specimen.

Specimens seen 953, as follows:

Canada: Ottawa 9 (U. S. N. M. No. 26496-7; E. R. D.); Godbout, Quebec 3 (U. S. N. M. No. 48056, 48081-2); St. Lawrence 1 (M. C. Z. No. 240).

Maine: Lake Oquassa 9 (U. S. N. M. No. 4735 TYPES of *borealis*); Rangeley 6 (M. C. Z. No. 2103, 2112); Bear Lake 6 (U. S. N. M. No. 36330-5); Paris Hill 7 (M. C. Z. No. 315); Norway 1 (P. S. N. H. No. 536); Sebago Lake 1 (Bowd. No. 71); Brunswick 9 (Bowd. No. 46, Pope No. 28, P. S. N. H. No. 537, 607); Topsham 2 (Bowd. No. 46); Auburn 5 (U. S. N. M. No. 13710-4); Winthrop 16 (Bowd. No. 46, 58, 86, Pope No. 28); Belgrade 12 (Bowd. No. *210*); Monmouth 1 (U. S. N. M. No. 36336); Manchester 37 (Bowd. No. 49, *84*, *86*, 89, Pope No. *29*, *46*, 50, *53*); Lexington 1 (P. S. N. H. No. 634).

New Hampshire: Meredith Bridge 1 (U. S. N. M. No. 3753); Amherst 2 (M. C. Z. No. 1193, Pope No. 6); Shelburne 1 (M. C. Z. No. 1945); North Conway 3 (M. C. Z. No. 4733-5); Farmington 1 (M. C. Z. No. 4983); Manchester 1 (Manning); Peterboro 2 (E. R. D.).

Vermont: Hartford 1 (U. Mich. No. 52221); Woodstock 5 (M. C. Z. No. 4507-11).

Massachusetts: Rowe 20 (M. C. Z. No. *175*); Chester 1 (Blanchard); Berkshire Hills 1 (A. N. S.); Berkshire Co. 1 (A. M. N. H. No. 3875); Mt. Toby 109 (S. C.); Goshen 5 (E. R. D.); Ashfield 6 (E. R. D.); Williamsburg 5 (E. R. D.); Florence 10 (E. R. D.); Northampton 11 (E. R. D., U. Mich. No. 50155); Springfield 1 (Springfield Mus. No. 3); Lunenburg 3 (Fassett); Leominster 2 (M. C. Z. No. 211); Medford 4 (M. C. Z. No. 1841); Watertown 5 (M. C. Z. No. 4512-6); Middlesex Fells 6 (E. R. D.); Waltham 1 (M. C. Z. No. 233); Auburndale 1 (M. C. Z. No. 1235); Boston 3 (M. C. Z. No. 4662-3, U. S. N. M. No. 13411); Forest Hills 2 (E. R. D.); Blue Hills 2 (E. R. D.); Newburyport 1 (M. C. Z. No. 8159); Wenham 4 (M. C. Z. No. 1202); Essex Co. 1 (A. N. S. No. 695); North Wrentham 1 (M. C. Z. No. 1829); Marion 2 (E. R. D.); Nantucket 1 (A. N. S.).

Connecticut: New Haven 10 (M. C. Z. No. 4497-506); Kent 1 (M. C. Z. No. 7108); Cobalt 3 (Wesleyan No. *535*).

Rhode Island: Providence 2 (A. M. N. H. No. 2511-2).

New York: St. Lawrence Co.: Madrid 4 (U. S. N. M. No. 3736); Westport 6 (U. S. N. M. No. 3745); Essex Co. 12 (U. S. N. M. No. 3740); Herkimer Co.: Wilmurt 1 (N. Y. St. Mus.); Mohawk 6 (Carnegie No. 1667-72); Cazenovia 4 (A. N. S., N. Y. St. Mus. No. 648); Berkshire 19 (M. C. Z. No. 232, 236,

238, 1114, 1116, 1909, 4571-6); Ithaca 28 (M. C. Z. No. 3148, U. Mich. No. 32432, 36028, 42466, U. S. N. M. No. 39407-8, Cornell 6560); McLean 3 (N. Y. St. Mus. No. 903); Gloversville 2 (N. Y. St. Mus. No. 436); Sacandaga Park 1 (N. Y. St. Mus. No. 94); Johnstown 1 (N. Y. St. Mus. No. 647); Small streams of Oneida Co. 42 (Roy. Ontario Mus. No. 484-507); Thompson's Lake 3 (N. Y. St. Mus. No. 98); Karners 5 (N. Y. St. Mus. No. 97-8); Coxsackie 17 (U. S. N. M. No. 3737); Catskills 14 (A. N. S., U. S. N. M. No. 23177-80, 23200, 23202-9); Halcottsville 9 (Brooklyn Mus. No. 978); Big Indian Valley 6 (Brooklyn Mus. No. 1260); Woodstock 1 (U. S. N. M. No. 3915); Ashokan 1 (A. M. N. H. No. 2150); Highland Falls 9 (U. S. N. M. No. 2313-21); Garrison 1 (A. M. N. H. No. 2243); Monsey 11 (A. M. N. H. No. 3658-63, 3677-81); Staten I. 2 (A. M. N. H. No. 2505-6); Long I. 2 (A. M. N. H. No. 3744-5); Cold Spring Harbor 10 (U. S. N. M. No. 52213-4, N. Y. St. Mus. No. 59); Smithtown 5 (Field Mus.).

New Jersey: Coytsville 6 (A. M. N. H. No. 6635-40); Edgewater 7 (A. M. N. H. No. 2498-504); Fort Lee 2 (A. M. N. H. No. 2509-10); Ridgewood 1 (M. C. Z. No. 2407); Plainfield 9 (M. C. Z. No. 2307); Morris Co. 1 (A. N. S.); Schwartzwood Lake 1 (A. N. S.); Schooley's Mt. 2 (M. C. Z. No. 1914); Warren Co.: White Pond 1 (A. N. S.); Atlantic City 1 (A. N. S.).

Pennsylvania: Allegheny Co.: Squaw Run 4 (Carnegie Mus.); Carnegie 1 (Carnegie Mus.); Emsworth 1 (Carnegie Mus.); Meadville 7 (U. S. N. M. No. 3718); western Pa. 2 (U. S. N. M. No. 3738); Port Allegheny 1 (A. N. S.); Newton Hamilton 1 (A. N. S. No. 18396); Brooklyn 1 (A. N. S.); Dingman's Ferry 1 (A. N. S.); Carlisle 19 (U. S. N. M. No. 3719, 3746); Monocacy 1 (A. N. S.); Columbia 1 (U. S. N. M. No. 3744); Gladwyne 1 (A. N. S.); Chester Co.: Londongrove 2 (M. C. Z. No. 6450); Delaware Co.: Brandywine Summit 1 (A. N. S.); Haverford 42 (U. S. N. M. No. 22706-8, E. R. D.); Holmesburg 1 (A. N. S.); Falls of Schuylkill 1 (A. N. S.); Germantown 1 (A. N. S.); Conshohocken 2 (H. C.); Philadelphia 1 (U. S. N. M. No. 3769).

Maryland: Jennings 2 (A. N. S. No. 17802, 18789); Bacon Hill, Cecil Co. 1 (A. N. S.); Prince George Co. 2 (U. S. N. M. No. 64930-1); Laurel 1 (U. S. N. M. No. 30016).

District of Columbia: Chain Bridge 1 (U. S. N. M. No. 55472); Piney Branch 1 (U. S. N. M. No. 17339); Takoma Park 4 (U. S. N. M. No. 17112-5); no locality 2 (U. S. N. M. No. 13329, 19935).

Virginia: Aqueduct Bridge 2 (U. S. N. M. No. 50004-5); Potomac above Washington 1 (U. S. N. M. No. 39432); Great Falls 1 (U. S. N. M. No. 50616); Alexandria 16 (E. R. D., M. C. Z. No. 7347); Ft. Myer 19 (U. S. N. M. No. 22415-31, 23129, E. R. D.); Bailey's Crossroads 1 (E. R. D.); Munson's Hill 2 (U. S. N. M. No. 17662-3); Loudoun Heights 1 (U. Mich. No. *52277*); Bluemont 1 (Cornell); Mt. Vernon 1 (E. R. D.); Berry's Ferry, Clarke Co. 11 (E. R. D.); The Plains 1 (E. R. D.); Delaplane 6 (U. S. N. M. No. 39020-3, 39026-7); Thornton Gap, Page Co. 2 (U. S. N. M. No. 59894-5); Stony Man Mt. 4 (U. S. N. M. No. 29265-6, 31629, 33895);

O'Connell's, Augusta Co. 10 (U. S. N. M. No. *36726*, *36747*, *36765*, *36767*, 36770-1, *36787*); Staunton 1 (Field Mus. No. 1901); Rawley 2 (U. S. N. M. No. 13586); James R. 60 (U. S. N. M. No. 3721); Lynchburg to Otter Peaks 1 (M. C. Z. No. 1429); Hollins 1 (U. S. N. M. No. *66990*); Midway 14 (A. M. N. H. No. 5052-3, M. C. Z. No. 5837-8, E. R. D.); Abingdon 3 (M. C. Z. No. 5838-40); Gloucester 5 (U. S. N. M. No. 3751).

West Virginia: Shepherdstown 7 (U. S. N. M. No. *51230-6*); Huntingground Mt. 1 (U. S. N. M. No. 36745); Durbin to Cheatbridge 2 (U. S. N. M.).

Ohio: Sandusky 5 (Field Mus. No. *2556*); Yellow Springs 2 (M. C. Z. No. 1192); Cincinnati 2 (U. S. N. M. No. 8823, 8832).

Indiana: Lafayette 1 (U. S. N. M. No. 17972); Indianapolis 4 (U. S. N. M. No. 17465-8); Wabash 1 (M. C. Z. No. 2552); Hanover 1 (U. Mich. No. 50230); Mitchell Cave 1 (Field Mus. No. 521); Putnam Co. and Vigo Co. 11 (M. C. Z. No. 7155-65).

Kentucky: Cumberland Gap 1 (M. C. Z. No. 7266); Bee Spring 2 (M. C. Z. No. *4701-2*).

Tennessee: Spring City 3 (M. C. Z. No. 5864-6).

It has also been recorded from the following additional localities:

New Brunswick: Curry's Mt., York Co., and St. John's River (Cox 1898).

Gaspe: New Carlisle (Cox 1899). Based on "larvae of *Desmognathus fuscus*" which are rarely met with and the species probably does not occur in Gaspe, whereas *bislineata* does occur that far north and its larvae are very commonly collected.

New Hampshire: First and Third Lakes (Doolittle 1908); Sunapee Lake (Kendall 1913); Hanover (Worthen 1891); Waterville (Evermann 1918); Intervale (Allen 1899); Squam Lake (Henshaw 1904).

Massachusetts: Salem (Holbrook 1842); Worcester (Horr, litt.).

Connecticut: Orange (Linsley 1844).

New York: Tioga Co.: Nichols (Cope 1889); Franklin Co.: Axton (Evermann 1918); White Plains (Deckert 1914); Albany Co.: Indian Ladder, Vorheesville, and Albany (Bishop 1923); Rochester and Bergen, Monroe Co., and Duck Lake, Wayne Co. (Wright and Moesel 1919).

Pennsylvania: Warren; Greenville, Mercer Co.; Indiana; Wellsboro, Tioga Co. (Surface 1913); Loyalsock, Lycoming Co. (Bishop 1925); Marshrun and Landisburg, Perry Co.; Pigeon Hills, York Co.; Zora, Adams Co.; Mont Alto, Franklin Co.; Bedford; Ararat, Susquehanna Co.; Stouchsburg, Berks Co.; Myerstown, Lebanon Co.; Bethlehem, Northampton Co.; Devon, Chester Co.; Highspire, Dauphin Co.; Willow Street, Lancaster Co.; Westtown, Philadelphia Co.; Allentown (Surface 1913); Aineyville, Summit Lawn and Slatedale, Lehigh Co. (Mattern 1917).

New Jersey: Beverley (Street 1914); Hunterdon Co. (Fowler 1908).

Delaware: Wilmington (Cope 1889); Hollyoak Run, Newark, Brown's Branch, Guyencourt, Montchanin (Fowler 1925).

Maryland: Gloucester (Cope 1889); Principio Furnace (Fowler 1925).

Ohio: Sugar Grove (Morse 1901); Montgomery Co., Worthington, Youngstown, Chilicothe, Licking Co. (Morse 1904); Columbus and Cleveland (Cope 1889).

Indiana: Vincennes (Gaines 1895); Brookville, Franklin Co. (Hughes 1886); Waveland, Montgomery Co. (Butler 1887); Monroe Co. (Hay 1887); Shelby Co. and Terre Haute (Hay 1891); Lake Maxinkuckee (Evermann and Clark 1917).

Michigan: (Clark 1905). No locality and no specimens support this record and it is extremely dubious.

Illinois: "Throughout" (Davis and Rice 1883); Charleston (Hawkinson 1915). The Charleston record was based on larvae of *Desmognathus fuscus,* and the same remarks apply here as were used above in connection with the Gaspe record of Cox.

Wisconsin: Racine (Hoy 1883, Cope 1889). Based on a specimen U. S. N. M. No. 3747, now lost. The record is dubious. "Southern Wisconsin" (Higley 1893).

EURYCEA BISLINEATA CIRRIGERA (GREEN)

1830 *Salamandra cirrigera* Green, Journ. Acad. Nat. Sci. Philadelphia 6, p. 253; Holbrook 1840, N. Amer. Herp. 4, p. 119, pl. 30; 1842, N. Amer. Herp. (2), 5, p. 53, pl. 15.

1849 *Spelerpes cirrigera* Baird Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 287; Gray 1850, Cat, Batr. Grad. Brit. Mus., p. 44; Hallowell 1858, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 346; Cope 1870, Amer. Nat. 4, p. 401.

1870 *Spelerpes cirrigerus* Strauch, Mém. Acad. Sci. St. Petersbourg (7), 16, 4, p. 82.

1877 *Spelerpes bilineatus cirrigera* Smith, The Tailed Amphibians, p. 84; Cope 1889, Bull. U. S. Nat. Mus. 34, p. 165.

1896 *Spelerpes bilineatus* Brimley, Amer. Nat. 30, p. 500 (habits); Beyer 1900, Proc. Louisiana Soc. Nat. 1897-99, App. 1, p. 10; Brimley 1907, Journ. Elisha Mitchell Sci. Soc. 23, p. 151; 1915, id. 30, p. 5.

1920 *Eurycea bislineata cirrigera* Dunn, Proc. Biol. Soc. Washington 33, p. 135; Blanchard 1922, Occ. Pap. Mus. Zoöl. U. Mich. 117, p. 4; Löding 1922, Alabama Mus. Pap. 5, p. 13; Stejneger and Barbour 1923, Check List (2), p. 16; Myers 1924, Copeia 131, p. 59.

1924 *Eurycea bislineata* Bishop, Bull. New York St. Mus. 253, p. 91; Brimley 1925, Copeia 139, p. 14.

Type: Not known to exist.

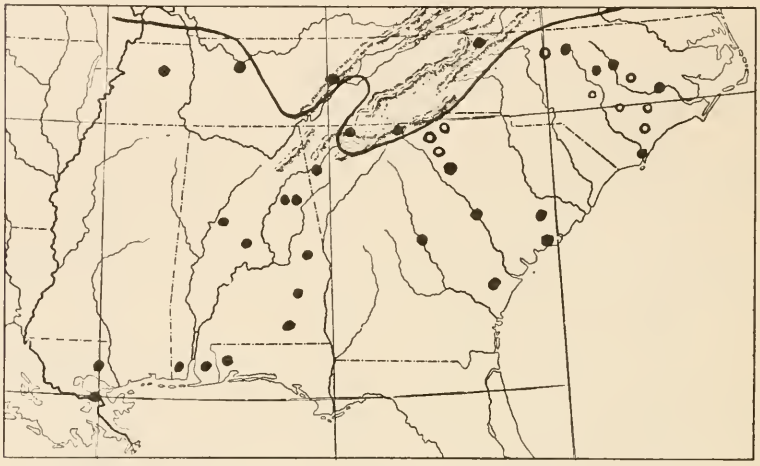
Type locality: New Orleans, La. Collected by Mr. William Stewart.

Range: From New Orleans, La., to Anniston, Ala., Camp Baranca, Fla., and Raleigh and Guildford, N. C.

Diagnosis: Similar to *E. bislineata bislineata* but male with cirri. Black stripe not breaking up on tail. Pigment below stripe with

large white mottlings, especially at base of tail; 14 costal grooves; total length to 96 mm.

Description: M. C. Z. 5800, adult male; Anniston, Ala. Costal grooves 14; 2 costal folds between appressed toes; head width 6½ in length of snout to vent; head length 3⅞ in length of body; head a blunted oval from above; eye shorter than its distance from tip of snout; snout swollen; sides of nasolabial groove prolonged downwards into a short cirrus whose tip is free from lip; outline of upper jaw straight as seen from side; angle of jaw forward of hind angle of eye; hind part of lower eyelid with groove into which upper fits so that part of lower is prolonged backwards spur fashion; a groove



46. Southeastern States, showing localities for Eurycea bislineata cirrigera (south of line), and nearest localities for E. b. wilderae and E. b. bislineata.

from lower eyelid to lip; a groove from eye back on sides of neck to gular fold; fingers 3, 2, 4, 1 in order of length; toes long, 4, 3, 2, 5, 1 in order of length; tail longer than head and body, a flattened oval in cross section, keeled above throughout and keeled below distally; anal lips lined with papillae; vomerine tooth row not connected with parasphenoids, about 4 in series, beginning behind inner edge of nares and curving in and back, separated by width of nares, and from parasphenoids by twice their own length; latter in two patches be-

ginning opposite hind edge of eyesocket; yellowish, a broad dark line from eye back on side to tip of tail, this distinctly bordered with lighter above on body; dorsal surface yellowish with a few irregularly placed black dots on body and head; sides below dark line faintly dusky; sides of tail dusky, much mottled with white near base, and distally merging into dark stripe above; legs mottled above with dusky, beneath immaculate; total length 96, head 8.5, body 32.5, tail 55.

Variation: A female, M. C. Z. 2098, New Orleans, La.; differs as follows: 3 costal folds between appressed toes; head length 4 in length of body; eye as long as its distance from tip of snout; snout less swollen; no cirrus; tail not keeled below; anal lips smooth; color similar but with second row of larval areas very large and distinct in lower part of dark dorsolateral line; total length 72, head 7, body 28, tail 37.

A larva, M. C. Z. 5806, Anniston, Ala., has 2 costal folds between the appressed toes; the upper row of larval areas is rather indistinct due to the lightening of the dorsal surface, but can be made out to consist of a little less than one area to every other costal fold; the middle row is present as a somewhat smaller series of light spots on about every costal fold extending well onto the tail; the lower row is between the insertions of the legs, one area to a costal fold just outlined below by pigment; total length 37, head 5, body 17, tail 15.

The normal coloration of this form is a marked dorsolateral stripe bordered with light above and with the second row of larval areas very conspicuous, especially on the base of the tail. Some males show premaxillary teeth enlarged, forward out of line with those on the maxilla, piercing the lip separately and in view when the mouth is closed.

Largest male	96	8.5	32.5	55	M. C. Z. 5800	Anniston, Ala.
Largest female	86	7	32	47	M. C. Z. 5791	Anniston, Ala.
Smallest adult	48	6	21	21	M. C. Z. 5805	Anniston, Ala.
Largest larva	74	7	30	37	M. C. Z. 6449	Morrisville, Ala.
Smallest larva	22	3.5	19.5	59	M. C. Z. 5828	Anniston, Ala.

Habits: Brimley (1896) speaking of the animal at Raleigh, N. C., says that it breeds from December to March and "the larvae first appear in May." "Except in the breeding season I believe it to be entirely terrestrial." I was able to observe nothing at Anniston or

Morrisville which could differentiate the habits from those of the typical race. Some larvae kindly sent me from Nashville by Mr. Harold Cummins were noted to have hatched out on April 12 from eggs found April 4.

Specimens seen 135, as follows:

Louisiana: New Orleans 2 (M. C. Z. No. 2098); Covington 3 (Viosca).

Alabama: Morrisville 7 (M. C. Z. No. 6443-9); Camp MacClellan 45 (M. C. Z. No. 5791-835); Mapleville 1 (M. C. Z. No. 4517); Shoal Cr., St. Clair Co. 1 (U. Ala.); University 1 (U. Ala.); Barbour Co. 1 (U. Ala.); Pinckard, Dale Co. 1 (U. Ala.); Auburn 1 (A. N. S. No. 14965); Mobile Co. 2 (U. S. N. M. No. 57159, 57161); Baldwin Co. 1 (U. S. N. M. No. 57160).

Florida: Camp Barranca, near Pensacola 6 (M. C. Z. No. 1375, 4552-6(5)); no locality 2 (A. N. S. No. 553).

Georgia: Riceboro, Liberty Co. 3 (U. S. N. M. No. 3748); Rome 2 (Cornell); Millidgeville 1 (U. S. N. M. No. 9463); no locality 3 (M. C. Z. No. 1913, 234, U. S. N. M. No. 4737).

Tennessee: Henry 1 (U. Mich. No. 53543); Nashville 28 (E. R. D.).

South Carolina: Abbeville 2 (U. S. N. M. No. 3798, 14457); Oakley 1 (U. S. N. M. No. 39491); Hamburg 1 (U. S. N. M. No. 61238); Charleston 1 (M. C. Z. No. *227*).

North Carolina: Kinston 3 (U. S. N. M. No. *8332*); Wilmington 5 (U. S. N. M. No. *37087-90*, E. R. D.); Raleigh 8 (M. C. Z. No. 4722, U. S. N. M. No. 16632-3, 57163-4, U. Mich. No. 50149, Field Mus. No. 1984(2)); Apex 1 (Field Mus. No. *816*); Guildford 1 (U. Mich. No. 52114).

It has also been recorded from Mandeville, La. (Beyer 1900); Micanopy, Fla. (Cope 1889); Bibb Co., Ala. (Löding 1922); Salem, N. C., and Anderson, S. C. (Cope 1889); Pendleton and Greeneville, S. C. (Holbrook 1842); Duplin, Johnston, Sampson, Harnett, and Pender Counties, N. C. (Brimley 1925); and Bridgewater, N. C. (Bishop 1924).

EURYCEA BISLINEATA WILDERAE DUNN

1870 *Spelerpes bilineatus* Cope, Amer. Nat. 4, p. 400; Brimley 1912, Proc. Biol. Soc. Washington 25, p. 139.

1917 *Spelerpes bislineatus* Dunn, Bull. Amer. Mus. Nat. Hist. 37, p. 618, pl. 59, f. 2, 8; pl. 60, ff. 3-4.

1920 *Eurycea bislineata wilderae* Dunn, Proc. Biol. Soc. Washington 33, p. 134; Stejneger and Barbour, Check List (2), p. 16; Breder and Breder 1923, Zoölogica 4, p. 15; Bishop 1924, Bull. New York St. Mus. 253, p. 91; Bishop 1925, Copeia 139, p. 11.

Type: M. C. Z. 5840, adult male, collected July 11, 1919, by E. R. Dunn.

Type locality: White Top Mt., Va., 4,000 feet, under a log in woods.

Range: From White Top Mt., Va.; south in mountains to Clayton, Rabun Co., Ga., and Cherry Log, Gilmer Co., Ga. Inhabits the whole Southern Blue Ridge region. Reaches 5,000 feet on White Top.

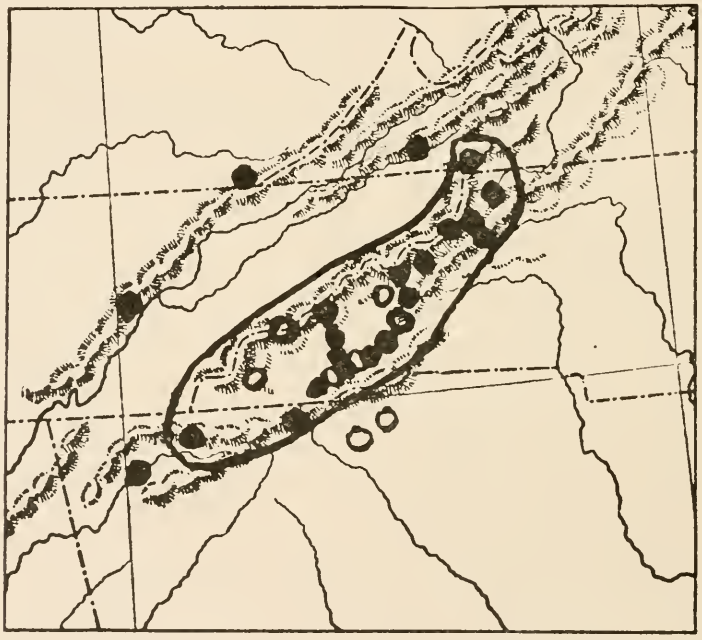
Diagnosis: Similar to *E. bislineata bislineata* but adult male usually with cirri. Somewhat more slender in form, tail longer, markings usually a narrow black line on sides, broken up or absent on distal half of tail, 14 costal grooves; total length to 93 mm.

Description: M. C. Z. 5848, adult male; White Top Mt., Va. (type). Costal grooves 14; four intercostal spaces between appressed toes; head width 6½ in length from tip of snout to vent; head length 4 in length of body; head an elongate oval with blunt snout; eye a little longer than its distance from tip of snout; snout swollen, especially below nostril, where the swelling projects free from edge of lip as a cirrus; outline of upper jaw convex as viewed from side; angle of jaw forward of hind angle of eye; hind part of lower eyelid with groove into which upper fits so that part of lower is prolonged backwards spur fashion; a groove from eye on side of neck to gular fold; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 4, 3, 2, 5, 1 in order of length; tail mutilated, a pointed ellipse in cross section; anus with lips lined with papillae; vomerine teeth not connected with parasphenoids, about 7 in series, beginning inside and back of inner border of nares, curving in and back, and separated by less than width of nares, and from the parasphenoids by a little less than their own length; latter beginning opposite hinder fourth of eyesocket, in two well separated patches; yellow, a narrow dark line from behind eye and above postocular groove, beginning as a series of spots, as a line on the body, and breaking again into spots on the tail; stripe distinctly bordered with lighter above and less distinctly below; region between stripes dotted with black; faint gray wash on sides; limbs gray above; ventral surface immaculate; total length 56, head 7, body 27, tail 20 (imperfect).

Variation: A female, M. C. Z. 5860, differs in having 14 costal grooves; head width 7½ in distance from snout to vent; head length 4 5/7 in length of body; snout less swollen, no cirrus; tail longer than head and body, a dorsal keel throughout; anal lips smooth; parasphenoid patches incompletely separated and distinct from vomerine

series by more than length of latter; color much darker than described male. From eye to base of tail a narrow black line, at base of tail this breaks into a row of spots which ceases at end of first half of tail. This line bordered above with lighter; on sides of body and tail and on upper surface of legs dark brown; between the dorsolateral stripes dark brown with small black spots; total 85, head 7, body 33, tail 45. A larva, M. C. Z. No. 5899, Sunburst, N. C., shows 3 costal folds between the appressed toes and has the upper larval areas confluent into an irregular jagged edged dorsal band; other two rows not evident; total length 51, head 7, body 23, tail 21.

Largest male	93	7.5	31.5	54	Univ. Mich. 62622	Pink Beds, N. C.
Largest female	90	7.5	32.5	50	Univ. Mich. 52537	Pink Beds, N. C.
Smallest adult	36	4.5	16	15.5	M. C. Z. 5855	White Top Mt., Va.
Largest larva	51	7	23	21	M. C. Z. 5899	Sunburst, N. C.
Smallest larva	17				A. M. N. H.	N. C.



47. Southern mountains, showing localities for Eurycea bislineata wilderae (outlined), and nearest localities for E. b. bislineata and E. b. cirrigera.

Habits: Of the habits of this form, I wrote (Dunn 1917), "We found the larvae of this species common in every small stream examined, and even in those as large as the Linville River. Adults were found rarely at Brevard. Only one adult and one transforming specimen were taken near there. At Linville both adults and larvae were common, but adults were found only on land under logs in situations similar to those chosen by various *Plethodons* and by *Desmognathus o. carolinensis,* in fact often in company with those species" and (Dunn 1920), "At Linville a batch of eggs was found hatching on July 19. They were attached to the under side of a stone in a brook just as are the eggs of *bislineata.*"

Remarks: The relationships have already been dealt with.

Specimens seen 132, as follows:

Georgia: Wilson's Gap 2 (Cornell No. 6497); Cherry Log, Gilmer Co., 3,000 ft. 1 (U. Ala.); Rabun Co. 3 (W. T. Davis); Clayton 1 (W. T. Davis).

Tennessee: Roan Mt. 1 (A. N. S.); Great Smoky Mts.? 1 (U. Mich. No. 42457).

North Carolina: Roan Mountain 8 (A. N. S. No. 4354, 10966); Beaver Creek 5 (Breder); Linville 35 (U. S. N. M. No. 55093-4, *55226,* M. C. Z. No. 5857-63, A. M. N. H. No. *4520-1,* 4599-600, 4664-5, 4678, 4699-709, 4857-63); Cranberry 1 (A. N. S. No. 4783); Cane R. 3 (A. M. N. H. No. 2213-4, U. S. N. M. No. 31156); Mt. Mitchell 2 (U. S. N. M. No. 31157, M. C. Z. No. 1115); Black Mts. 4 (A. N. S. No. 10662); Montreat 1 (U. S. N. M. No. 50049); Burnsville 1 (U. S. N. M. No. *31124*); Brevard 9 (A. M. N. H. No. 4155, *4335-7, 4353-4, 4356-7, 4499*); Pisgah Forest Reserve 14 (U. Mich. No. 52621-9, U. S. N. M. No. *55228-31,* A. M. N. H. No. *4454*); Transylvania Co. 1 (U. S. N. M. No. 61303); Flat Rock 1 (A. M. N. H. No. 21197); Henderson Co. 3 (A. N. S. No. 681); Highlands 1 (U. S. N. M. No. 36788); Sunburst 1 (M. C. Z. No. 5899); Waynesville 5 (Chapin); Mt. Sterling 11 (M. C. Z. No. *5867-76*).

Virginia: White Top Mt. 17 (M. C. Z. No. 5841-56 TYPES).

It has also been recorded from Weaverville, Black Mt., Blantyre, Toxaway, and Andrews, in North Carolina (Brimley 1912), from Stoney Mt. near Hendersonville (Bishop 1924); and from Linville Gap, N. C. (Bishop 1925).

EURYCEA MULTIPLICATA (COPE)

1869 *Spelerpes multiplicatus* Cope, Proc. Nat. Sci. Philadelphia, p. 106; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 67; Cope 1889, Bull. U. S. Nat. Mus. 34, p. 162, f. 39; Strecker 1908, Proc. Biol. Soc. Washington 21, p. 88; Hurter and Strecker 1909, Trans. Acad. Sci. St. Louis 18, 2, p. 17; Hurter 1911, id. 20, 3, p. 89; Bailey 1913, North Amer. Fauna 35, p. 35.

1884 *Geotriton multiplicatus* Garman, Bull. Essex Inst. 16, p. 39.

1917 *Eurycea multiplicata* Stejneger and Barbour, Check List, p. 20; Dunn 1918, Bull. Mus. Comp. Zoöl. 62, p. 470; Stejneger and Barbour 1923, Check List (2), p. 17.

Type: U. S. N. M. 4038, collected by Dr. L. A. Edwards.

Type locality: Red River in eastern Oklahoma (Cope says Arkansas but the expedition narrative makes it clear that they were collected in Oklahoma). (See Marcy's "Exploration of the Red River").

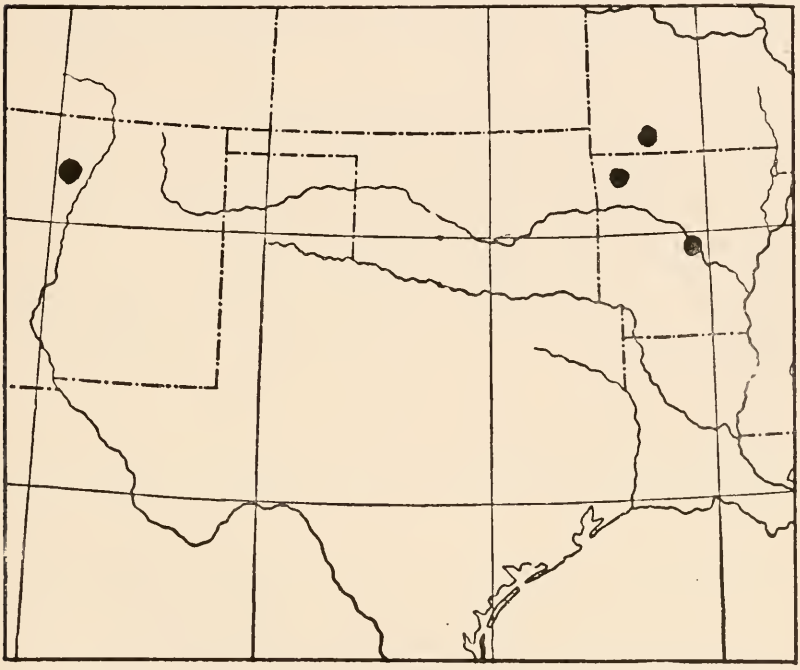
Range: From Stone Co., Mo., to Little Rock, Ark. The Jemez Mts., N. Mex. Distribution apparently very discontinuous and the animal is common only in the Ozark region.

Diagnosis: A *Eurycea* with 20 costal grooves, weak limbs and the habitus of *Plethodon cinereus*.

Description: M. C. Z. No. 2983, adult male; Pulaski Co., Ark.; 20 costal grooves; 9 costal folds between appressed toes; head width 6½ in length from tip of snout to vent; head length 4½ in length of body; head a pointed oval; eye longer than its distance from tip of snout; snout swollen; a swelling of upper lip below nostril but no developed cirrus; outline of upper jaw straight as viewed from sides; angle of jaw just forward of hind angle of eye; hind part of lower eyelid with groove into which upper fits so that part of lower projects backwards spur fashion; a groove from lower eyelid to angle of jaw; a groove from eye back on sides of neck to gular fold; limbs short; fingers 3, 2, 4, 1 in order of length; toes 3, 4, 2, 5, 1 in order of length, first very short; tail longer than body, cylindrical at base, flattened at tip, keeled above throughout; anal lips lined with papillae; vomerine teeth not connected with parasphenoids, 6-7 teeth in series, curving in and back from level of inner edge of nares, separated from each other by the width of nares and from the parasphenoid by ⅔ their own length; parasphenoids in two well separated patches beginning at the posterior fourth of eyesocket; grayish, a brownish dorsal band extending over head and dorsal surface of tail, light on sides and belly; total length 68 mm., head 6.5, body 20.5, tail 32.

Variation: An adult female, Field Museum No. 538, Fayetteville, Ark., has 8 costal folds between the appressed toes; the head width is 9 in length from tip of snout to vent; the head length is 5 in the length of body; the snout is less swollen; tail shorter than body; anal lips smooth; vomerine series separated from parasphenoids by their own length; almost uniform brown above, lighter below; total length

69, head 6.5, body 32.5, tail 30. A larva, same data shows traces of the three rows of larval areas of which the upper is almost obscured in the generally lighter dorsal surface, the middle is very close beneath the upper, and the lower is indistinct and near the lower edge of the pigmentation; total length 47, head 5, body 22, tail 20. A male from Little Rock, Ark., M. C. Z. 2430, shows the coloration well.



48. Missouri and New Mexico, showing localities for Eurycea multiplicata.

There is a dark line from the eye over the insertions of the legs to the tip of the tail, a gray band below this with the middle and lower rows of larval areas near the upper and lower edges; above the dark line, yellowish brown with dark dots on the median line.

Largest male	90	7.5	39.5	43	U. S. N. M. 57167	Stone Co., Mo.
Largest female	81	6.5	33	42.5	U. S. N. M. 57173	Pulaski Co., Ark.
Smallest adult	41	5	25	11	U. S. N. M. 36961	Little Rock, Ark.
Largest larva	47	5	22	20	Field Mus. 538	Fayetteville, Ark.

Habits: Hurter (1911) says, "From under rocks lying in the water and at the edge of a small brook emerging from a spring." Hurter and Strecker (1909) mention its being eaten by *Desmognathus brimleyorum.*

Remarks: As mentioned under *E. bislineata,* I am inclined to believe it related to *multiplicata.* The relationship, however, is not very close and the animals have been distinct for a long time.

The specimens from New Mexico, U. S. N. M. 42921-2, I refer with some doubt to the species. They are in very bad condition.

Specimen seen 43, as follows:

New Mexico: Jemez Mts. 2 (U. S. N. M. No. 42921-2).
Oklahoma: Red River 5 (U. S. N. M. No. 4038 TYPES).
Arkansas: Fayetteville 9 (Field Mus. No. 538, U. S. N. M. No. 55253-6); Pulaski Co. 10 (M. C. Z. No. 2983-4, U. S. N. M. No. 57122-9); Little Rock, Pulaski Co. 13 (U. S. N. M. No. 36960-1, M. C. Z. No. 2930, 4961-4, Am. Mus. No. 2517, A. N. S., Cornell).
Missouri: Stone Co. 4 (U. S. N. M. No. 57167-8, Field Mus.).

It has also been recorded from southern Kansas (Cope 1889); Marble Cave, Stone Co., Mo., and Granite Cave near Little Rock, Ark. (Hurter 1911).

EURYCEA MELANOPLEURA (COPE)

1894 *Spelerpes melanopleurus* Cope, Proc. Acad. Nat. Sci., p. 383.
1917 *Eurycea melanopleura* Stejneger and Barbour, Check List, p. 19; Dunn 1918, Bull. Mus. Comp. Zoöl. 62, p. 469; Stejneger and Barbour, Check List (2), p. 17.
1901 *Spelerpes stejnegeri* Eigenmann, Trans. Amer. Micr. Soc. 22, p. 189, pl. 27-8 (Wilson's Cave, Jasper Co., Mo.); Hurter 1903, Trans. Acad. Sci. St. Louis 13, 3, p. 79; Eigenmann 1909, Publ. Carnegie Inst. 104, p. 28, pl. 1, f. B, Bb; Hurter 1911, Trans. Acad. Sci. St. Louis 20, 3, p. 87.
1917 *Eurycea stejnegeri* Stejneger and Barbour, Check List, p. 20.

Type: A. N. S. 10456-60, young, collected by E. D. Cope.

Type locality: Riley's Cr., a tributary of the White River, Mo.

Range: From Franklin Co., Mo., and Jasper Co., Mo., to Little Rock, Ark. Extends into Texas and probably into Oklahoma and Kansas. It occupies the Ozark and Ouachita Provinces.

Diagnosis: Similar to *E. longicauda* but pigment absent from middorsal line, so that there is frequently a paired row of spots down the back; tail clouded on sides, not barred; sides of body dark; male with short thick cirri.

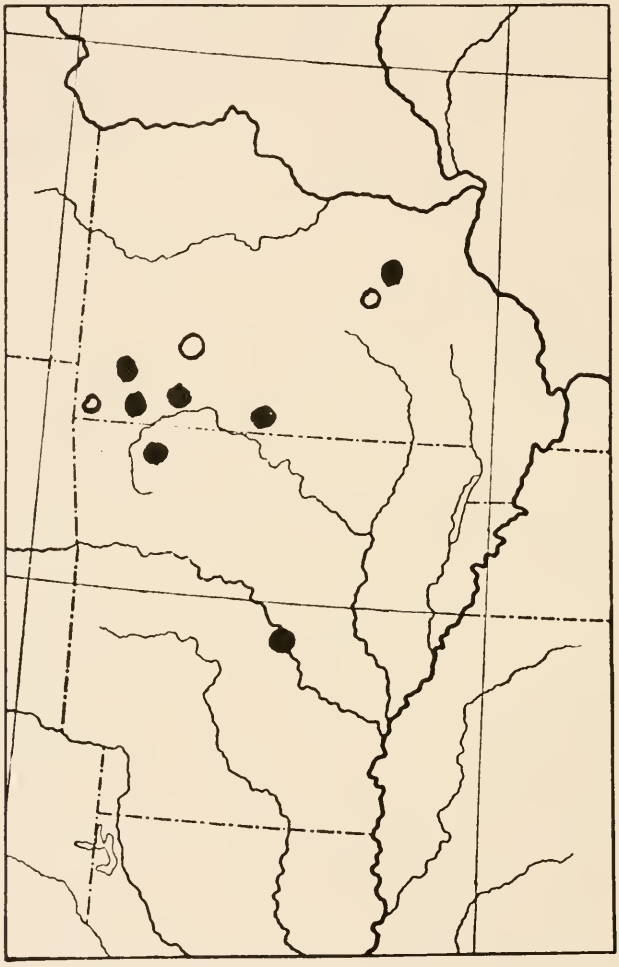
Description: M. C. Z. No. 2538, adult male; Stone Co., Mo.; costal grooves 13; appressed toes just meeting; head width 5⅞ in length from snout to vent; head length 3⅓ in length of body; eye as long as its distance from tip of snout; head an elongate oval with blunt snout; snout swollen; sides of naso-labial groove swollen and prolonged into a short thick cirrus which is free from edge of lip; outline of upper jaw straight as viewed from side; angle of jaw just forward of hind angle of eye; hind part of lower eyelid with groove into which upper fits so that part of lower is prolonged backwards spur fashion; a groove from angle of jaw to groove of lower eyelid; a groove from eye on sides of head backwards, not meeting gular fold; latter on sides of neck to level of insertion of arms; limbs well developed, fingers 3, 2, 4, 1 in order of length; toes long, 3, 4, 2, 5, 1 in order of length; tail much longer than head and body, an elongate oval in section, distinct keel on dorsal and ventral surfaces in distal half; anus with lips lined with papillae; vomerine teeth, 12-13 in series, not connected with parasphenoids, beginning behind middle of nares and curving inwards and backwards towards its fellow from which width of nares separates it, series ending at first third of eyesocket; parasphenoids in two patches, separated from vomerines by length of vomerine series, beginning at hind fourth of eyesocket; yellowish-brown, diffuse black spotting, traces of dorsolateral stripe, otherwise dorsal and lateral surface rather uniformly spotted or marbled with black save for mid-dorsal line of body and tail; ventral surface immaculate; total length 126, head 11.5, body 40, tail 74.5.

Variation: A female, M. C. A. No. 2551, Wilson's Cave, Jasper Co., Mo. (cotype of *Spelerpes stejnegeri* Eigenmann); has 14 costal grooves; one costal fold between appressed toes; head length 3⅔ in length of body; snout not much swollen, a slight swelling of upper lip below nostril; ventral edge of tail not keeled; anal lips smooth; color as in described male but less spotting on dorsal surface, so that pigment is in two lateral stripes and two dorsal rows of spots divided by the median line; total length 112, head 9.5, body 35, tail 69.5.

A young one, M. C. Z. 4609, Wilson's Cave, Mo., has 14 costal grooves; 3 costal folds between appressed toes; head width 6 in length from tip of snout to vent; a broad black band on sides of head, body and tail; upper surface immaculate; total length 62.5, head 6.5, body 22, tail 33. A larva, M. C. Z. 3486, from Reed's Spring, Stone Co.,

Mo., shows the upper row of larval areas as unpigmented spots arranged in two dorsolateral rows, they are not yet confluent; lower rows not evident; pigmentation very black and chin pigmented; total length 32, head 5, body 14, tail 13.

The upper rows early become confluent into the dorsal light stripe,



49. Missouri and Arkansas, showing localities for Eurycea melanopleura.

the middle row appears on the dark sides about one to every other costal fold, and the lower is of very irregular spots between the insertions of the legs.

The variation in the costal groove count is due to the position of the axillary which sometimes goes directly into the armpit and sometimes is well removed from it, causing another groove to appear.

Largest male	131	11.5	47	82	U. S. N. M. 57138	Stone Co., Mo.
Largest female	148	13	52	83	U. S. N. M. 38792	Sarcoxie, Mo.
Smallest adult	44	5.5	18	20.5	M. C. Z. 3777	Stone Co., Mo.
Largest larva	46	5.5	20.5	20	Univ. Mich. 47760	Iron Spring, Stone Co., Mo.
Smallest larva	20	3.5	8	8.5	U. S. N. M. 57137	Jasper Co., Mo.

Habits: Hurter (1911) says, "This species is also a twilight species, as it is mostly found under slabs of rock at the mouth of caves and never a very great distance into the cave. At Wilson's Cave, a small cave, I found this salamander among the rocks which dam the little creek at the mouth of the cave. When I visited the cave there was no running water but a little pool just inside the cave. I managed to capture a few small larvae." "Near Marble Cave I found a good many of these salamanders in holes under rocks at the bottom and sides of the caves, where they were clinging to the rocks. At Green's Cave, Franklin Co., which has a large portal-like entrance, I caught some of them under rocks in the water, but not further back in the cave than daylight penetrated. Those from Jerome and from near the Onondago Cave were caught under rocks on the shady side of a hill in an open pasture."

Remarks: This is a close ally of *gutto-lineata* and of *longicauda*. Its range adjoins theirs but seems not to overlap. Hurter (1911) gives some overlapping records for *melanopleura* and *longicauda* in Missouri but these are confirmed neither by his own nor any other specimens I have seen. He records them both from Green's Cave near Sullivan and *longicauda* from Ozark, Miller, and Washington counties. I have seen no *longicauda* from these localities but I have seen *melanopleura* from Green's Cave and from Ozark Co. Of the three it is not easy to decide as to the most primitive and it is probable that each has retained some of the original characters. Sexual dimorphism would make *longicauda* the oldest, *gutto-lineata* the youngest. In coloration it is probable that *melanopleura* represents the ancestral type, for it has the early youth pattern of *gutto-lineata*

without showing the undue prominence of the lower row of larval areas in which the latter and *quadridigitata* are peculiar. *Melanopleura* has quite the longest vomerine tooth rows of the three, and the longest head, and these seem in general to be primitive characters. The probability is that they developed in *situ* from one wide ranging ancestor and no one of them is ancestral to either of the other two.

Stejnegeri Eigenmann is the adult of Cope's *melanopleura*.

Specimens seen 62, as follows:

Texas: No locality 1 (M. C. Z. No. 244).

Arkansas: Lawrence Co. 2 (U. S. N. M. No. *64898, 64900*); Pulaski Co. 2 (U. S. N. M. No. 57178-9); Carroll Co. 1 (U. S. N. M. No. 57149).

Missouri: Riley's Creek. White R. 5 (A. N. S. No. 1056-60 TYPES); Barry Co.: Rockhouse Cave 1 (U. S. N. M. No. 61259); Stone Co. 28 (M. C. Z. No. 2280, 2538, 3776-7. U. S. N. M. No. 37047, 38793-5, *57134*, 57138-46, 57148, *57169-70, 58723-6*. Cornell, Field Mus.); Stone Co.: Iron Spring 3 (U. S. N. M. No. 52331. U. Mich. No. *47759-60*); Stone Co.: Reed's Spring 1 (M. C. Z. No. *3485*); Stone Co.: Marble Cave 1 (Field Mus.); Jasper Co. 7 (U. S. N. M. No. 38792, 57132-3, *57135-7*, 57148); Jasper Co.: Sarcoxie 1 (U. S. N. M. No. 37048); Jasper Co.: Wilson's Cave 4 (M. C. Z. No. 2551 TYPE of *stejnegeri*, 2270, 4609-10); Ozark Co. 1 (U. S. N. M. No. 57125); Phelps Co. 1 (U. S. N. M. No. 57131); Franklin Co.: Green's Cave 3 (U. S. N. M. No. 37409, 57126-7).

It has also been recorded from the following Missouri localities: Fisher's Cave near Springfield, Greene Co. (Hurter 1903); Pineville, McDonald Co.; Jerome, Phelps Co.; Leasburg, Crawford Co. (Hurter 1911).

EURYCEA LONGICAUDA (GREEN)

1818 *Salamandra longicauda* Green, Journ. Acad. Nat. Sci. Philadelphia 1, p. 361; Rafinesque 1832, Atlantic Journ. 1, 2, p. 63; Smith 1833, Geol. Rept. Massachusetts, p. 552; Holbrook 1838, N. Amer. Herp. 3, p. 111, pl. 26; 1842, id. (2), 5, p. 61, pl. 19; DeKay 1842, Zoöl. New York 3, p. 78, pl. 17, f. 41; Linsley 1844, Amer. Journ. Sci. Arts 46, p. 50; Matthes 1855, Allg. deut. nat. Zeitschr. 1, p. 261.

1838 *Cylindrosoma longicauda* Tschudi, Mém. Soc. Sci. Nat. Neuchâtel, p. 58.

1843 *Saurocercus longicauda* Fitzinger, Syst. Rept., p. 35.

1849 *Spelerpes longicauda* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 287; Gray 1850, Cat. Batr. Grad. Brit. Mus., p. 43; Hallowell 1856, Proc. Acad. Nat. Sci. Philadelphia, p. 11; 1858, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 345; Abbott 1868, Geol. Surv. New Jersey, p. 803; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 64; Worthen 1891, Vert. Hanover, New Hampshire, p. 61; Garman 1894, Bull. Essex Inst. 26, p. 38; Lönnberg 1899,

Zoöl. Anz., p. 545 (lunglessness); Morse 1901, Ohio Nat. 1, p. 115; Ditmars 1905, Amer. Mus. Nat. Hist. Journ. 5, p. 174, f. 10; Clark 1905, Rept. Michigan Acad. Sci. 7, p. 110; Stone 1906, Amer. Nat. 40, p. 66; Fowler 1907, Rept. New Jersey Mus. 1906, p. 66, pl. 13; 1908, id. 1908, p. 394; Surface 1913, Zoöl. Bull. Pennsylvania Dept. Agric. 3, 3-4, p. 100, f. 11; Keim 1914, Copeia 2; Fowler 1915, Proc. Delaware Co., Inst. Sci. 7, p. 8; Miller 1916, Copeia 34, p. 67; Mattern 1917, Copeia 46, p. 64.

1861 *Spelerpes longicaudus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 124; 1869, id., p. 107; Quick 1882, Journ. Cincinnati Soc. Nat. Hist. 5, p. 96; Hughes 1886, Bull. Brookville Soc. Nat. Hist. 2, p. 44; Butler 1887, Journ. Cincinnati Soc. Nat. Hist. 9, p. 264; Hay 1887, Journ. Cincinnati Soc. Nat. Hist. 10, p. 61; Cope 1889, Bull. U. S. Nat. Mus. 34, p. 168, f. 41, pl. 28, f. 1-3, pl. 35, f. 11; Garman 1891, Bull. Illinois Lab. Nat. Hist. 3, p. 367; Hay 1892, Rept. Indiana Dept. Geol. 17, p. 447; Higley 1893, Wisconsin Acad. Sci. Arts 7, p. 172; Gaines 1895, Amer. Nat. 29, p. 55; Blatchley 1899, Rept. Indiana Dept. Geol., p. 540; Hay 1902, Proc. Biol. Soc. Washington 15, p. 126; Houghton 1903, Ohio Nat. 3, p. 379 (muscles); Morse 1904, Proc. Ohio Acad. Sci. 4, p. 113; Whipple 1906, Biol. Bull. 11, p. 1 (nasolabial groove); Banta and McAtee, Proc. U. S. Nat. Mus. 30, p. 80 (larvae); McAtee 1907, Proc. Biol. Soc. Washington 20, p. 14; Hahn 1908, Proc. U. S. Nat. Mus. 35, p. 555; Eigenmann 1909, Carnegie Inst. Pub. 104, p. 28, pl. 2, ff. A, Aa; Hurter 1911, Trans. Acad. Sci. St. Louis 20, p. 85; Dunn 1915, Copeia 25, p. 63; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 20.

1884 *Geotriton longicauda* Garman, Bull. Essex Inst. 16, p. 39.

1917 *Eurycea longicauda* Stejneger and Barbour, Check List, p. 19; Dunn 1918, Copeia 53, p. 67; 1918, Bull. Mus. Comp. Zoöl. 62, p. 468; 1920, Proc. Biol. Soc. Washington 33, p. 134; Blanchard 1922, Occ. Pap. Mus. Zoöl. U. Mich. 117, p. 4; Stejneger and Barbour 1923, Check List (2), p. 16; Bishop 1923, Copeia 118, p. 67; Holt 1924, Copeia 135, p. 94; Bishop 1925, Copeia 139, p. 11; Fowler 1925, Copeia 145, p. 62.

1826 *Salamandra longicaudata* Harlan 1826, Journ. Acad. Nat. Sci. Philadelphia 5, p. 331.

1840 *Salamandra longe caudata* Troost, Geol. Tennessee, p. 40.

1854 *Cylindrosoma longicaudatum* Duméril and Bibron, Erp. Gén. 9, p. 78.

1883 *Spelerpes longicandus* Hoy, Geol. Wisconsin 1, p. 426.

1900 *Spelerpes longicudus* Moore, Proc. Acad. Nat. Sci. Philadelphia, p. 619 (vertebrae).

1906 *Spelerpes longecaudus* Whipple, Biol. Bull. 10, p. 257 (ypsiloid).

1832? *Triturus lutescens* Rafinesque, Atlantic Journ. 1, 3, p. 121 (western Kentucky).

Type: Not known to exist.

Type locality: New Jersey (probably near Princeton).

Range: From Albany, N. Y., to Georgia, and to Lawrence Co., Ark. Occupies the Appalachian Valley and Plateau mostly south of

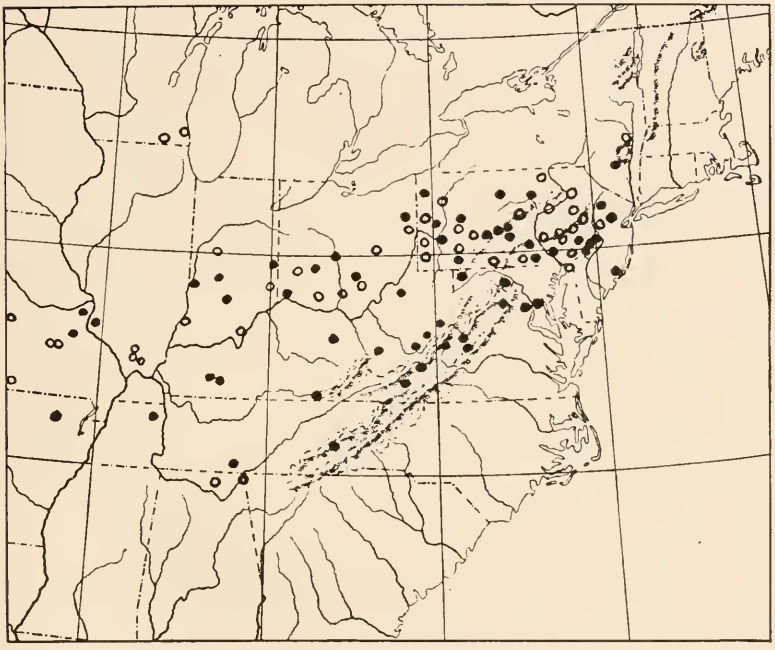
the glaciation, a part of the Central Lowland, part of the Piedmont and Coastal Plain north of the Potomac.

Diagnosis: A *Eurycea* with 13 costal grooves, yellow ground color, 5 toes, a very long tail, pigment on dorsal surface in more or less scattered spots, some of which are on mid-dorsal line, pigment on tail in vertical bars, male without developed cirri and without premaxillary fangs.

Description: M. C. Z. No. 5679, adult male; Mt. Sterling, N. C. Costal grooves 13; appressed toes just meeting; head width 6½ in length from tip of snout to vent; head length 4½ in length of body; head an elongate oval; eye as long as its distance from tip of snout; snout swollen; a swelling of upper lip below nostril, but no developed cirrus; outline of upper jaw straight as viewed from side; angle of jaw just forward of hind angle of eye; hind part of lower eyelid with groove into which upper fits so that part of lower is prolonged backwards spur fashion; a groove from eye along side of head to gular fold, latter on sides of neck to dorsal surface; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes long, 4, 3, 2, 5, 1 in order of length; tail much longer than head and body, an elongate oval in section, a distinct dorsal keel in distal half; anus with lips lined with papillae; vomerine teeth not connected with parasphenoids, beginning behind middle of nares and curving inwards and backwards to meet its fellow series from which it is separated by width of nares, about 9 teeth in series which ends at first fourth of eyesocket; parasphenoids in two patches beginning at last fourth of eyesocket and separated from vomerines by more than the length of latter; yellow, a black line from eye along postocular groove to gular fold, in continuation of this a line of black spots the size of iris to level of vent; back between these rows with smaller spots arranged mainly in median line; no spotting on head between or in front of eyes; sides with small spots; limbs with small spots above; tail with mid-dorsal line immaculate, more or less dumb-bell shaped bars on sides separated by their own width; a few spots on sides of throat, rest of ventral surface immaculate; head 11, body 50, tail 89, total length 144.

Variations: A female, M. C. Z. No. 4492, Hot Springs, Va., differs as follows: appressed toes separated by one costal fold; head length 3⅘ in length of body; snout less swollen; a perceptible projection of upper lip below nostril; anal lips smooth; vomerine and parasphenoid

series separated by ⅔ length of vomerine; color similar to described male but with little trace of any lateral row of spots larger than the others and dorsal surface of body uniformly dotted; total length 158, head 13, body 50, tail 95. A larva, M. C. Z. 7272, from Clarke Co., Va., has the appressed toes nearly touching; the upper row of larval areas is confluent into a dorsal-lateral light band which extends to the tip of the tail and is incompletely separated from its fellow of the



50. Middle States, showing localities for Eurycea longicauda.

opposite side by dots on the mid-dorsal line; middle and lower series not evident due to the scanty pigmentation of the sides; total length 43, head 5.5, body 17.5, tail 20.

Largest male	151	13	46	92	M. C. Z. 2779	Jefferson Co., Mo.
Largest female	158	13	50	95	M. C. Z. 4492	Hot Springs, Va.
Smallest adult	44	6.5	20.5	17	U. S. N. M. 57200	St. Louis Co., Mo.
Largest larva	43	5.5	17.5	20	M. C. Z. 7272	Clarke Co., Va.
Smallest larva	30	4	13	13	M. C. Z. 7268	Haverford, Pa.

Habits: I have met with this species at four places. Near Haverford, Pa., I took two larvae and a small transformed animal under stones at an old spring issuing from a wall against a hill. The country rock whose outcrops were all about was Wissahickon mica gueiss. At Newtown Square, Pa., I saw an adult in the water of a small spring. It seemed thoroughly at home and its actions were more like those of a larva than of an adult. In Clarke Co., Va., near the Shenandoah River, several larvae and adults were caught in and around springs issuing from limestone. At Mt. Sterling, N. C., one adult was found under a log, near a road which went up the valley of a small stream between wooded hills. The actions of the individuals were all similar and gave little indication of the agility so noticeable in their southern relative *gutto-lineata.* Ditmars (1905) "took large numbers of specimens along a mountain stream, at the Delaware Water Gap, Pennsylvania. They were hiding under flat stones in the bed of a nearly dry stream." Hurter (1911) says, "It occurs on the sides of cold water creeks under flat stones at the entrance to caves, where they are found under rocks partly in water. In Green's Cave, near Sullivan, Crawford Co., Mo., I found one under a large slab, nearly 3,000 feet from the entrance of the cave where no daylight could penetrate. They resemble lizards in the quickness of movement when attempting to escape." (These remarks of Hurter's may really apply rather to *melanopleura,* which certainly occurs in Green's Cave). Surface (1913) from the food in 45 stomachs found "spiders, mites, pseudoscorpions, thousand-legged 'worms,' various forms of insects and vegetable matter such as grass." Morse (1901) says that at Sugar Grove, Ohio, "It may be found in May under stones at the edge of the water together with its eggs; the eggs are attached to the under side of a hollow stone."

Remarks: The relationships of this form are with *melanopleurs* and with *gutto-lineata.* Some specimens (M. C. A. 218, Georgia), are quite close to *gutto-lineata* (see Dunn 1918, p. 469). I do not believe that intergradation takes place at the present time because the animals occur near each other at Mt. Sterling, N. C., and are both on the Coastal Plain in West Tennessee, *gutto-lineata* at Henry and Como, *longicauda* at Big Sandy less than 30 miles away. None of these specimens show any signs of intergradation. The Big Sandy *longicauda* is not quite typical. Both it and the specimens from

Missouri are dull colored and the markings are blurred and indistinct. I now believe that *longicauda* away from the Appalachian Valley and Plateau and the Central Lowland in the south is somewhat abnormal. This would account for the difference observed in Coastal Plain *longicauda* in Tennessee and Missouri and for the Georgia specimens which probably came from either Blue Ridge or Piedmont. In general, *longicauda* differs from *gutto-lineata* in having a great deal less black pigment, and in having much less pronounced sexual dimorphism. It stays west of the Blue Ridge north to the Potomac. There it comes east onto Piedmont and apparently Coastal Plain. There seems no reason to doubt the Atlantic City specimen in the Academy of Natural Sciences, yet I confess that I should like to see others from the Coastal Belt.

Specimens seen 144, as follows:

New York: Ashokan 1 (A. M. N. H. No. *2518*).

New Jersey: Plainfield 2 (U. S. N. M. No. 55470, A. M. N. H. No. 1598); White Pond, Warren Co. 1 (A. N. S.); Atlantic City (A. N. S.).

Pennsylvania: Meadville 2 (U. S. N. M. No. 3732, 16281); Pittsburg 2 (U. S. N. M. No. 3860); Cambria Co.: Cresson 1 (A. N. S.); Indiana Co.: Indiana 1 (A. N. S.); Two Lick Creek 1 (A. N. S.); Two Lick Hills 1 (A. N. S.); Mifflin Co.: Newton Hamilton 1 (A. N. S.); Clinton Co.: Round Island 1 (A. N. S.); Altoona 1 (A. N. S.); Huntingdon 1 (A. N. S.); Lancaster Co. 1 (A. N. S.); York Co.: Sowego Creek 1 (A. N. S.); Chester Co.: Valley Forge 1 (A. N. S.); Delaware Co.: Swarthmore 1 (A. N. S.); Brandywine Summit 1 (A. N. S.); Coopertown Road 3 (E. R. D.); Newtown Square 1 (E. R. D.); Carlisle 1 (N. Y. St. Mus.); Philadelphia Co.: Chestnut Hill 3 (A. N. S.); Wissahickon 1 (A. N. S.); Williamsport 1 (Cornell); Somerset Co. 1 (Cornell No. 4492); Butler 2 (S. C.).

Maryland: Jennings 1 (A. S. N.); Oakland 1 (U. S. N. M. No. 33653).

District of Columbia: Rock Creek 1 (U. S. N. M. No. 55471); High Island 1 (U. S. N. M. No. 61721).

Virginia: Hot Springs 1 (M. C. Z. No. 4492); O'Connell's, Augusta Co. 2 (U. S. N. M. No. 36752, 36776); Staunton 1 (Field Mus. No. 1900); Endless Caverns 2 (S. C.); Berry's Ferry, Clarke Co. 5 (E. R. D.); Spring Hill, Fairfax Co. 1 (Biol. Survey); Wytheville 1 (U. S. N. M. No. 14447); Giles Co. 1 (A. N. S.).

North Carolina: Mt. Sterling 1 (M. C. Z. No. 5679).

Georgia: No locality 4 (M. C. Z. No. 218, A. N. S. No. 711).

West Virginia: Jefferson Co. 5 (U. S. N. M. No. 60059-63); Big Spring Run, Pocahontas Co. 2 (U. S. N. M. No. 33631-2); Shaver's Fork, Randolph Co. 2 (U. S. N. M. No. 43203-4); Petroleum Lake 1 (M. C. Z. No. 1108); Barger's Spring 3 (U. S. N. M. No. 27490, 33648-9); Baileysville 3 (U. S. N. M. No. 33618-9, 33585).

Ohio: Trumbull Co. 1 (U. S. N. M. No. 57191); Yellow Springs 14 (M. C. Z. No. 1112, 1886); Lancaster 1 (U. S. N. M. No. 4085); Columbus 1 (U. S. N. M. No. 3735); Cincinnati 2 (U. S. N. M. No. 8842, 8846).

Indiana: Monroe Co. 1 (U. S. N. M. No. 57195); Richmond 1 (U. S. N. M. No. 21381); Vigo Co. and Putnam Co. 11 (M. C. Z. No. 7155-65).

Illinois: St. Clair Co. 1 (U. S. N. M. No. 57193).

Kentucky: Morgan Co. 1 (U. S. N. M. No. 57192); Cumberland Gap 12 (M. C. Z. No. 2225); Mammoth Cave 4 (M. C. Z. No. 1111, 2226, U. S. N. M. No. 29662-3); Bee Spring 1 (M. C. Z. No. *995*); Edmonson Co. 3 (M. C. Z. 1107, 2227).

Tennessee: Franklin Co. 2 (U. S. N. M. No. 8826, 57194); Big Sandy 1 (U. S. N. M. No. 45959).

Missouri: St. Louis Co. 5 (M. C. Z. No. 2301, U. S. N. M. No. 57198-201); Cliff Cave, St. Louis Co. 2 (U. S. N. M. No. 45933, Cornell No. 4291); Jefferson Co. 5 (U. S. N. M. No. 57196-7, M. C. Z. No. 2779, 3149, Cornell).

Arkansas: Lawrence Co. 1 (U. S. N. M. No. *64897*).

It has also been recorded from the following additional localities:

New Hampshire: Hanover (Worthen 1891). A very dubious record.

Massachusetts: (Smith 1835). A hearsay record and very dubious.

Connecticut: Canaan and Salisbury (Linsley 1844). Hearsay records and dubious.

New York: Albany (De Kay 1842).

Pennsylvania: Swissvale and Carnegie, Allegheny Co.; Johnstown, Cambria Co.; Wilkinsburg, Indiana Co.; Volen, Lawrence Co.; Mance, Somerset Co.; Emlenstown, Venango Co.; Hickory and Cannonsburg, Washington Co.; Zora, Adams Co.; McConnellsburg, Fulton Co.; Danville, Montour Co.; Hamburg and Springville, Berks Co.; Troy, Bradford Co.; Weissport, Carbon Co.; Harrisburg and Dauphin, Dauphin Co.; Lietitz, Lancaster Co.; Meyerstown and Schaefferstown, Lebanon Co.; Pittstown, Luzerne Co. (Surface 1913); Allentown, Lehigh Co. (Mattern 1917); State College, Center Co.; Cave Hill, Cumberland Co.; Loyalsock, Lycoming Co.; Port Allegany, McKean Co. (Bishop 1925).

New Jersey: Hunterdon Co. (Fowler 1908).

Maryland: Conowingo (Fowler 1925).

Tennessee: Union Co. (Cope 1889). Based on a specimen of *lucifuga,* U. S. N. M. No. 8821.

Georgia: Augusta (Cope 1889). Based on a specimen of *lucifuga,* U. S. N. M. No. 8803.

Alabama: Monte Sano, Madison Co. (Löding 1922); Long Island, Jackson Co. (Holt 1924).

Ohio: Sugar Grove (Morse 1901); Montgomery Co., Youngstown, Chillicothe, and Ellis Station (Morse 1904); Highland Co., and West Northfield (Cope 1889); Pentelton (Matthes 1855).

Indiana: Vincennes (Gaines 1895); Montgomery (Butler 1888); Harrison Co. (Hay 1891); Franklin Co. (Hughes 1886).

Illinois: Makanda, Cobden, Saratoga, and Johnson Co. (Garman 1891).

Wisconsin: Racine (Hoy 1883); Walworth Co. (Higley 1893). These are rather dubious in the absence of specimens.

Missouri: Washington Co., Miller Co., Green's Cave near Sullivan in Crawford Co., and Ozark Co. (Hurter 1911). The last two are rather dubious as being well within the range of *melanopleura*, and while I have seen Hurter's collection, I have seen no specimens of *longicauda* or of *melanopleura* which would indicate an overlapping.

Michigan: (Clark 1905). A very dubious record.

EURYCEA GUTTO-LINEATA (HOLBROOK)

1838 *Salamandra gutto-lineata* Holbrook, N. Amer. Herp. 2, p. 61, pl. 12; 1842, id. (2), 5, p. 29, pl. 7.

1840 *Salamandra guttolineata* Troost Geol. Rep. Tennessee, p. 39.

1849 *Spelerpes gutto-lineata* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 287; Gray 1850, Cat. Batr. Grad. Brit. Mus., p. 45.

1854 *Cylindrosoma guttolineatum* Duméril and Bibron, Erp. Gén. 9, p. 79.

1856 *Spelerpes gutto-lineata* Hallowell, Proc. Acad. Nat. Sci. Philadelphia, p. 11.

1869 *Spelerpes guttolineatus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 167; 1870, Amer. Nat. 4, p. 399; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 65; Fisher 1887, Amer. Nat., p. 672; Cope 1889, Bull. U. S. Nat. Mus. 34, p. 170, f. 42; Brimley 1896, Amer. Nat., p. 500 (habits); Lönnberg 1899, Zoöl. Anz., p. 545 (lack of lungs); Whipple 1906, Biol. Bull. 10, p. 257 (ypsiloid); 1906, id. 11, p. 1 (naso-labial groove); Hurter 1911, Trans. Acad. Sci. St. Louis 20, 3, p. 89; Brimley 1912, Proc. Biol. Soc. Washington 25, p. 139; Dunn 1917, Bull. Amer. Mus. Nat. Hist. 37, p. 616, f. 5; pl. 59, ff. 6-7, pl. 60, f. 2; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 21.

1884 *Geotriton guttolineata* Garman, Bull. Essex Inst. 16, p. 39.

1909 *Spelerpes gutto-lineatus* Allard, Science (N. S.) 30, p. 122.

1917 *Eurycea gutto-lineata* Stejneger and Barbour, Check List, p. 19; Dunn 1920, Proc. Biol. Soc. Washington 33, p. 134; Blanchard 1922, Occ. Pap. Mus. Zoöl. U. Michigan 117, p. 4; Löding 1922, Alabama Mus. Paper 5, p. 14; Stejneger and Barbour 1923, Check List (2), p. 16; Schmidt 1924, Copeia 132, p. 68; Bishop 1924, Bull. New York St. Mus. 253, p. 91.

1918 *Eurycea guttolineata* Dunn, Copeia 53, p. 19; 1918, Bull. Mus. Comp. Zoöl. 62, p. 468; Potter 1920, Copeia 86, p. 82.

1896 *Spelerpes gluttolineatus* Hopkins, Amer. Nat., p. 832 (lunglessness).

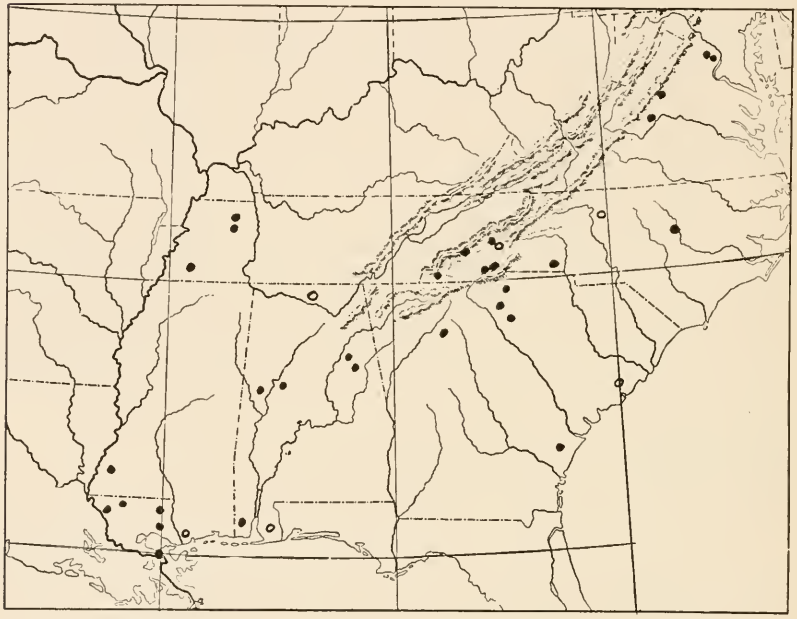
Type: A. N. S. No. 716-7, Greenville, S. C.

Type locality: "Carolina in the middle country."

Range: From Fairfax Co., Va., to Mt. Sterling, N. C., Liberty Co., Ga., New Orleans, La., and Henry, Tenn. Occupies southern part of Coastal Plain and Piedmont, Southern Blue Ridge and extreme southern part of Appalachian Valley. Reaches 2,500 feet altitude in the North Carolina mountains.

I am inclined to doubt the Fort Lee specimen, A. M. N. H. 3804, collected by Dr. Mearns and should feel surer if others were turned up. A specimen in the University of Michigan collection, 42467, with locality "Tennessee," was collected in a lot with *P. r. schencki, Plethodon jordani,* and *Gryinophilus danielsi,* therefore it probably came from somewhere in the Smokies. The Tennessee River seems to limit this form to the northwards.

Diagnosis: A *Eurycea* with 13-14 costal grooves; yellow ground



51. Southeastern States, showing localities for Eurycea gutto-lineata.

color; short curved vomerine series; 5 toes; a very long tail; pigment on dorsal surface a median stripe; pigment on tail a lateral dark band; male with cirri and premaxillary fangs.

Description: M. C. Z. No. 5203, adult male: Crozet, Va.; costal grooves 13; one costal fold between appressed toes; head width 6⅓ in length from snout to vent; head length 3½ in body length; head an elongate oval with blunt snout; eye as long as its distance from tip

of snout; snout swollen; sides of naso-labial groove swollen and prolonged into a cirrus which is free from upper lip; outline of upper jaw straight as seen from side; angle of jaw just forward of hind angle of eye; hind part of lower eyelid with a groove into which upper fits so that part of lower is prolonged backwards spur fashion; a groove from angle of jaw to groove of lower lid; a groove on side of neck from eye to gular fold; latter on sides of neck to level of insertion of arm; limbs well developed; fingers 3, 2, 4, 1 in order of length; toes 3, 4, 2, 5, 1 in order of length; tail much longer than head and body, an elongate oval in section, a distinct dorsal keel nearly throughout its length; anus with lips lined with papillae; vomerine teeth 9 in series beginning behind inner border of nares and curving inwards and backwards towards each other but separated by width of nares, distant from parasphenoids by their own length and ending opposite first third of eyesocket; parasphenoids in two imperfectly separated patches beginning opposite last fourth of eyesocket; two enlarged teeth on premaxilla emerge outside edge of lip: brownish yellow; a black stripe from eye back above insertion of legs and continued onto the tail; a black mid-dorsal stripe from back of head to above vent; an irregular light stripe from insertion of arm to insertion of leg; a white dot on nearly every costal fold on dorsolateral black stripe; sides of head, limbs and whole ventral surface mottled with black; dorsal surface of tail brownish yellow, sides black, ventral surface mottled; head 11.5, body 42.5, tail 90, total length 144.

Variation: A female, M. C. Z. No. 5677, Anniston, Ala., has 14 costal grooves; head width 6 in length from snout to vent; head length 4 in length of body; snout less swollen; a projection of upper lip below nostril but no cirrus; anal lips smooth; sides of tail with considerable white arranged in irregular broken vertical bars; total length 159, head 12, body 49, tail 98.

A larva, M. C. Z. 5778, Mt. Sterling, N. C., has the upper larval areas confluent in two dorsolateral light bands separated by a median dark streak which appears double; middle row consists of light dots on the dark lateral streak, one to a costal fold; lower row a light streak between the insertions of the legs, bordered above by the lateral dark streak and below by a dark stripe about as wide as the lower row; appressed toes separated by one costal fold; total length 50, head 6, body 20, tail 24.

Largest male	166	13	43	110	U. S. N. M. 38547	Thompson's Mills, Ga.
Largest female	161	12.5	48.5	100	U. S. N. M. 57154	Mobile, Ala.
Smallest adult	49	6.5	22.5	20	U. S. N. M. 57158	Mobile, Ala.
Largest larva	50	6	20	24	M. C. Z. 5778	Mt. Sterling, N. C.
Smallest larva	19				A. M. N. H.	Brevard, N. C.

Habits: My first experience with this salamander was at Brevard, N. C., when I was walking alongside a ditch at night with a carbide light in my hand. The ditch was roofed over by blackberry bushes and was some six feet deep. As I cast the beam of light about, I saw a large salamander of this species on a blackberry twig over the ditch about a foot above ground and hence seven feet from the bottom. When I tried to catch it, it dropped from the twig and disappeared. Later I found them common and active at night in the bottoms of such ditches. They were entirely too active to be easily caught and most of my specimens from that locality were taken in daytime when they were hiding under stones near water or under débris at the edge of the high water of the 1916 French Broad flood. Elsewhere I have found them mainly near springs. They are excessively agile and difficult to catch, rather a contrast to *longicauda* which is easily caught.

Brimley (1896) says of it near Raleigh, N. C., "It can be taken containing eggs in November."

Remarks: This very distinct and beautiful species has avoided synonomy more than most salamanders.

Specimens seen 139, as follows:

New Jersey: ? Fort Lee 1 (A. M. N. H. No. 3804).

Virginia: Dunn Loring, Fairfax Co. 1 (U. S. N. M. No. 17556); Munson's Hill, Fairfax Co. 1 (U. S. N. M. No. 17662); Crozet 2 (M. C. Z. No. 5203, 5678); Wingina, Nelson Co. 1 (W. T. Davis).

North Carolina: Raleigh 13 (Cornell No. 4290, U. S. N. M. No. 16634, 19634-6, 57150, A. M. N. H. No. 2513-4, 3090); Gaston Co. 1 (M. C. Z. No. 1303); Henderson Co. 1 (A. N. S.); Flat Rock 2 (A. M. N. H. No. 21195-6); Brevard 20 (A. M. N. H. No. 4156-60, *4168*, *4171-4*, *4344-8*, 4368, 4459, *4498*, 4502, *4710*); Marshall 6 (A. M. N. H. No. 3997-9, 5274-6); Andrews 1 (M. C. Z. No. 2539); Mt. Sterling 17 (M. C. Z. No. 5774-90).

South Carolina: Anderson 1 (U. S. N. M. No. 3720); Abbeville 2 (U. S. N. M. No. 4733, 7051); Greenville 2 (A. N. S. No. 716-7 TYPES); Hamburg 1 (U. S. N. M. No. 61233).

Georgia: Augusta 1 (M. C. Z. No. 325); Riceboro 1 (U. S. N. M. No. 3749); Thompson's Mills 2 (U. S. N. M. No. 38547-8).

Alabama: Camp McClellan near Anniston 1 (M. C. Z. No. 5677); Morrisville 1 (M. C. Z. No. 5676); Eutaw 1 (U. S. N. M. No. 3723); Mobile Co. 11

(M. C. Z. No. 2777, 3150, U. S. N. M. No. 42552-3, 57154-8, A. N. S.); University, Tuscaloosa Co. 2 (U. Ala.).

Mississippi: Oxford 1 (U. Mich. No. 52446); Water Valley 1 (M. C. Z. No. 4493); Jefferson Co. 3 (U. S. N. M. No. 57151-3).

Louisiana: New Orleans 1 (M. C. Z. No. 2100); Covington 6 (Viosca, U. S. N. M. No. 53171); Clinton 1 (U. S. N. M. No. 16676); Port Hudson 1 (M. C. Z. No. 1109); 10 miles west of Bogalusa 8 (Viosca).

Tennessee: Moscow 6 (U. Mich. No. 53142-7); Henry 7 (U. Mich. No. 53544-5, 53557, 53559-62); Como 11 (U. Mich. No. 53546-56); ? Great Smoky Mts. 1 (U. Mich. No. 42467).

No locality: 1 (A. M. N. H. No. 2515).

It has also been recorded from the following additional localities:

North Carolina: Salem (Cope 1889); Bridgewater; Minehole Gap, Buncombe Co. (Bishop 1924); Weaverville (Brimley 1912).

South Carolina: Otranto (Schmidt 1924).

Mississippi: Bay St. Louis (Brimley 1910); Rodney, Jefferson Co. (Hurter 1911).

Alabama: Madison Co. and Baldwin Co. (Löding 1922).

Louisiana: Como (Beyer 1900).

Missouri: New Madrid Co. (Banta and McAtee 1906, Hurter 1911). The specimens on which this record is based are U. S. N. M. No. 3733, four larvae of *Ambystoma texanum*. They were described as larvae of *gutto-lineata* by Banta and McAtee.

EURYCEA QUADRIDIGITATA QUADRIDIGITATA (HOLBROOK)

1842 *Salamandra quadridigitata* Holbrook, N. Amer. Herp. (2), 5, p. 65, pl. 21.

1849 *Batrachoseps quadridigitata* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 287.

1850 *Batrachoseps quadridigitatus* Gray, Cat. Batr. Grad. Brit. Mus., p. 42; Hallowell 1856, Proc. Acad. Nat. Sci. Philadelphia, p. 11; 1858, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 348.

1869 *Manculus quadridigitatus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 101; 1877, Proc. Amer. Phil. Soc. 17, p. 63; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 75; Yarrow 1883, Bull. U. S. Nat. Mus. 24, p. 22; Cope 1889, Bull. U. S. Nat. Mus. 34, p. 159, f. 38, pl. 27, ff. 5-7, pl. 35, f. 12; Lönnberg 1894, Proc. U. S. Nat. Mus. 17, p. 337; 1896, Zoöl. Anz. 19, p. 34 (lunglessness); Wilder 1896, Anat. Anz. 12, p. 190 (lunglessness); Brimley 1896, Amer. Nat. 30, p. 500 (habits); Boettger 1906, Zoöl. Beob. Frankfurt 47, p. 88 (cirrus); Whipple 1906, Biol. Bull. 10, p. 257 (ypsiloid); 1906, Biol. Bull. 11, p. 1 (naso-labial groove); Kinsbury and Reed 1908, Journ. Morph. 20, p. 576 (otic apparatus); Rea 1910, Bull. Charleston Mus. 6, p. 35; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 21; Stejneger and Barbour 1917, Check List, p. 18; Dunn 1918, Bull. Mus. Comp. Zoöl. 62, p. 270; Reed 1920, Journ. Morph. 33, p. 345 (otic ap-

paratus); Steiner 1921, Anat. Anz. 53, p. 513, f. 6 (tarsus); Löding 1922, Alabama Mus. Pap. 5, p. 13; Brimley 1923, Copeia 120, p. 81 (habits).

1923 *Manculus quadridigitatus quadridigitatus* Stejneger and Barbour, Check List (2), p. 14; Schmidt 1924, Copeia 132, p. 68.

1884 *Manculus quadridigitata* Garman, Bull. Essex Inst. 16, p. 40.

1923 *Eurycea quadridigitata quadridigitata* Dunn, Proc. New England Zoöl. Club 7, p. 40.

1894 *Spelerpes bilineatus* Test, Bull. U. S. Fish Comm. 12, p. 122.

Type: ? A. N. S. 490.

Type locality: South Carolina, Georgia and Florida.

Range: From Raleigh and Kinston, N. C., to Gulfport and Oviedo, Fla., Jennings, La., and Palestine, Texas. A Coastal Plain species apparently on the Piedmont at Abbeville, S. C.

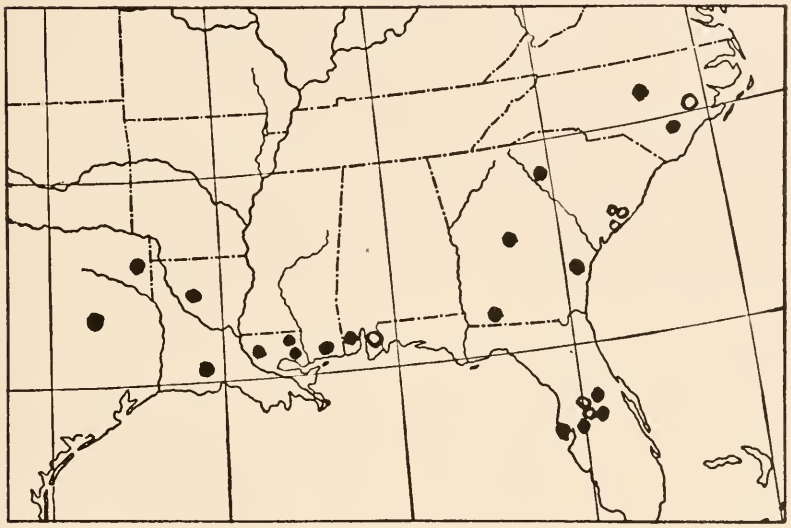
Diagnosis: A *Eurycea* with 4 toes, yellow ground color, 16 costal grooves, long tail, pigment in form of dorsolateral stripe.

Description: M. C. Z. No. 3575, adult male; Gulfport, Fla.; 16 costal grooves; 5 costal folds between appressed toes; head width 7 in length from tip of snout to vent; head length 4 in length of body; head an oval; eye longer than its distance from tip of snout; snout swollen; sides of naso-labial groove swollen and produced downwards into a short blunt cirrus; outline of upper jaw convex as viewed from side; angle of jaw just forward of hind angle of eye; a groove from eye along sides of neck to gular fold; latter dorsally to sides of neck; limbs slight; fingers 3, 2, 4, 1 in order of length; toes 3, 4, 2, 1 in order of length; tail much longer than head and body, subquadrangular in cross section, a distinct dorsal keel throughout, flattened distally; anal lips lined with papillae; vomerine series not connected with parasphenoids, 3-4 teeth in each, beginning at level of inner edge of nares, curving inwards and backwards, separated by ½ width of nares, and from parasphenoids by twice their own length; latter in two imperfectly separated patches extending as far forward as hind edge of eyesocket; yellowish gray, a dusky vertebral line on body forking on occiput, a black streak from eye along groove as far as gular fold, thence forming a dark lateral band and extending to tip of tail, a narrow bright line between insertions of legs, below this dark becoming gradually lighter on the mid-ventral region, both surfaces of limbs and throat dusky; total length 77 mm., head 6, body 25, tail 46.

Variation: A female, M. C. Z. No. 7275, Raleigh, N. C., differs as follows: head length 4⅘ in length of body; snout less swollen; no

cirrus; no keel on tail; anal lips smooth; parasphenoids well separated; color similar to that of described male but with light line between legs less distinct and belly unpigmented; total length 71, head 5, body 24, tail 42.

Larvae have the third row of larval areas confluent into a line as in larvae of *E. gutto-lineata*. Also as in *gutto-lineata* several males seen have the enlarged premaxillary teeth piercing the lip.



52. Southeastern States, showing localities for Eurycea quadridigitata quadridigitata.

Largest male	78	6	26	46	U. S. N. M. 16678	Covington, La.
Largest female	81	6	28	47	U. S. N. M. 3804	Riceboro, Ga.
Smallest adult	32	4	13	15	U. S. N. M. 8867	No locality
Largest larva	26.5	3	13.5	10	U. S. N. M. 8867	No locality

Habits: Brimley (1896) states that this species is terrestrial save in January and February when it enters the water to breed. In a letter (December 9, 1920) he says that *quadridigitata* at Raleigh, N. C., "enters the trickle from feeble springs, these usually well covered with dead leaves or débris, in December, and lays its eggs in January or February. Eggs are laid *singly*, on dead leaves lying in

the water and look much like *Spelerpes (bislineatus)* eggs but smaller."

Later (1923) he adds: "The species breeds in mid-winter and is seldom to be met with at other times . . .

"The most favorable spot for finding this species has always been where the runlet from a certain small spring trickles sluggishly down a narrow cut about nine inches deep, into and out of a larger but not very vigorous spring some two yards below, and thence for a like distance until it loses itself in a wet marsh. Both these outlets are always choked with dead leaves in various stages of decay, and it is among these the salamanders and their eggs are found.

"On visiting this place on December 23, 1922, I found plenty of the salamanders but no eggs . . .

"I then resolved to visit it again in January but the opportunity did not arrive till the first day of February, and on this occasion there were eggs of this species in abundance but the adults had mostly disappeared, a few, however, had not laid their eggs and were still present. The eggs were scattered about among the dead and decaying leaves lying in the water in the runlets from both springs, mostly singly, but occasionally in groups of from three to six, and on one leaf I counted four of these groups. They were not, however, attached to each other in any way or to any extent, nor did they adhere to the leaves any more than other similarly wet and gelatinous substances would naturally do. The eggs are of the usual 'Spelerpes' type, unpigmented and about 2 mm. or less in diameter. The only other date I have on record for eggs is December 20, 1916, for which I have the following note: 'Took twenty-five . . . saw a few eggs, but most had not laid.'

"I have found these salamanders not infrequent in the trickles from feeble springs and in the ooze from springy slopes near marshes, from the middle of October till late April, but except in the height of the breeding season, seldom more than one or two at a time. They can also be found at the same season under logs and rubbish in the damp lowgrounds.

"The larvae mostly hatch out in March, transforming to adults two or three months later."

Lönnberg (1894) says of it in Florida: "I have found this animal under old logs at the border of a small lake at Clarcona and at Lake

John, and caught it in my dipnet in Fern Creek, near Orlando, Orange County. On land it is rather swift running, and lives in localities similar to those which are frequented by *Leiolopisma laterale*."

Remarks: I cannot think the genus *Manculus* worthy of recognition. The sole difference from *Eurycea* is the absence of the fifth toe. I think it probable that *quadridigitata* was derived from *gutto-lineata*, and is a more terrestrial offshoot of that species. These two alone have the peculiar development of the lower row of larval areas into a light stripe. The mid-dorsal dark streak is fairly prominent in both. The sexual dimorphism is more pronounced in *quadridigitata* than in any other species but *gutto-lineata* is a close second.

Along the east coast of Florida there seems to be a race of this species *Eurycea quadridigitata remifera* (Cope). The Floridian examples hereinafter referred to the typical form unquestionably belong to it, and *remifera* has been seen only from Sebastian.

Specimens seen 101, as follows:

North Carolina: Raleigh 27 (S. C., Cornell No. 3114, M. C. Z. No. 4076, U. Mich. No. 52416, A. M. N. H. No. 2296-310, U. S. N. M. No. 57395-6); Magnolia 3 (Cornell No. 6757).

South Carolina: Abbeville 1 (U. S. N. M. No. 3904); no locality 1 (A. N. S. No. 490 TYPE).

Georgia: Riceboro 1 (U. S. N. M. No. 3804); Bibb Co. 2 (U. S. N. M. No. 39510-1); Thomasville 1 (A. N. S.).

Florida: Gulfport 1 (M. C. Z. No. 1375); Oviedo 1 (U. S. N. M. No. 21328); Enterprise 1 (A. N. S. No. 4830); Esmeralda, Lake Co. 3 (U. S. N. M. No. 69854); Auburndale 1 (U. S. N. M. No. *53260*).

Alabama: Mobile Co. 2 (U. S. N. M. No. 42554-5); no locality 3 (U. S. N. M. No. 57392-4).

Louisiana: Chastine 22 (Cornell); Mandeville 1 (U. S. N. M. No. 9337); Covington 18 (Viosca, U. S. N. M. No. 16678-82); Jennings 2 (Cornell); Pearl River 2 (Viosca); Horshan 3 (Viosca); Indian Mound 1 (Viosca); 10 miles west of Bogalusa 1 (Viosca).

Mississippi: Biloxi 1 (U. S. N. M. No. 51156).

Texas: Lake Caddo 1 (A. M. N. H. No. 6949); Palestine 1 (U. S. N. M. No. 17700).

It has also been recorded from the following localities:

North Carolina: Kinston (Cope 1871).

South Carolina: Charleston (Rea 1910); Mt. Pleasant, Otranto, and Summerville (Schmidt 1924).

Florida: Clarcona, Lake John, and Fern Creek near Orlando (Lönnberg 1894).

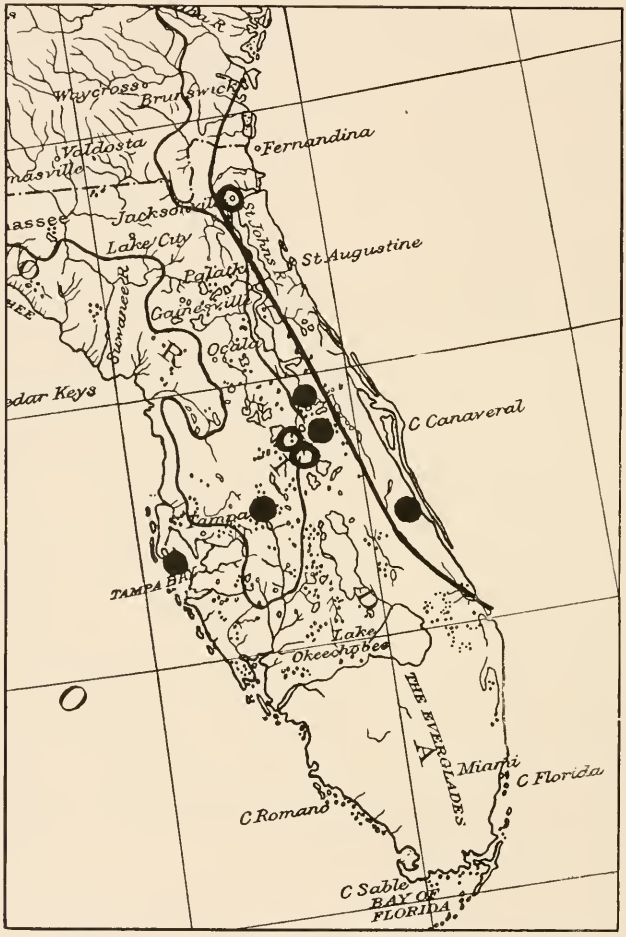
Alabama: Baldwin Co. (Löding 1922).

EURYCEA QUADRIDIGITATA REMIFERA (COPE)

1871 *Manculus remifer* Cope, Rep. Peabody Acad. Salem, p. 84; Boulenger 1882, Cat. Bat. Grad. Brit. Mus., p. 76; Cope 1889, Bull. U. S. Nat. Mus. 34, p. 158; Stejneger and Barbour 1917, Check List, p. 18.

1923 *Eurycea quadridigitata remifera* Dunn, Proc. New England Zoöl. Club 8, p. 40.

1923 *Manculus quadridigitatus remifer* Stejneger and Barbour, Check List (2), p. 14.



53. Florida, showing localities for Eurycea quadridigitata remifera (east of line), and nearest localities for E. q. quadridigitata.

Type: Now lost.

Type locality: Jacksonville, Florida.

Range: Known only from type locality and from Sebastian, Florida.

Diagnosis: Like *Eurycea quadridigitata quadridigitata* but with longer vomerine series, and much darker in color, the sides with tiny white dots.

Description: M. C. Z. No. 8726, adult female; Sebastian, Florida; 16 costal grooves; 5 costal folds between appressed toes; head width 7 in length from snout to vent; head length 4½ in length of body; head a blunt oval; eye as long as its distance from tip of snout; snout not swollen; a slight projection of upper lip below naso-labial groove, but no cirrus; outline of upper jaw convex as seen from side; angle of jaw just forward of hind angle of eye; a short groove from angle of jaw to groove of lower lid; hind part of lower lid with groove into which upper fits so that part of lower is prolonged backwards spur fashion; a groove from eye to gular fold; limbs slight; fingers 3, 2, 4, 1 in order of length; toes 3, 4, 2, 1 in order of length; tail longer than head and body, subquadrangular in cross-section, a distinct dorsal keel, slightly flattened distally; anus with smooth lips, shape an inverted V; vomerine series not connected with parasphenoids, 8 teeth in each, beginning behind inner edge of nares, curving in and then nearly straight back, separated by width of nares and from parasphenoids by four times that distance; latter in two narrow patches beginning opposite hind edge of eyesocket; very dark; dorsal area slightly lighter, being brown heavily dotted with black, almost indistinguishable from black sides; belly white heavily mottled with brown; throat and under side of tail black; a line of tiny white dots between insertions of legs; a few such dots scattered on sides above this line, many below on dark sides of belly and tail and on throat; total length 68 mm., head 5.5, body 24.5, tail 38.

Variation: A male, M. C. Z., same data, has short cirri, and enlarged premaxillary teeth, which do not pierce lip; the anus is a straight slit and is lined with papillae; total length 60 mm., head 5, body 20, tail 35.

Another female, M. C. Z. No. 8730, same data, shows no significant differences; total length 55 mm., head 5, body 22, tail 28.

A large larva, M. C. Z. No. 8729, same data (the largest of 52 larvae), is like the larva of *quadridigitata* but darker. The lowest row

of larval areas is a stripe; total length 46 mm., head 6, body 15, tail 25.

Habits: The whole series of 3 adults and 52 larvae was taken during the digging of a drainage ditch.

Remarks: Absolutely nothing was learned concerning this animal from the time of the original description in 1871 until the spring of 1922, when Mr. George Nelson, of the Museum of Comparative Zoölogy, brought back quite a series from Sebastian. Meanwhile the type had been lost, and as typical *quadridigitata* occurs in the interior of Florida, and on the west coast as far as Gulfport (practically opposite Sebastian), it was believed that *remifer* could only be a synonym.

This form is related to the typical race and is apparently restricted to the extreme coastal strip of eastern Florida.

It is further from other members of the genus in color than is the typical race, yet in vomerine dentition it is quite similar to *guttolineata,* and has apparently retained the primitive dentition while developing its specialized coloration.

Specimens seen 55, as follows: ·

Florida: Sebastian 55 (M. C. Z. No. 8718-40).

EURYCEA LUCIFUGA RAFINESQUE

1822 *Eurycea lucifuga* Rafinesque, Kentucky Gazette, Lexington (N. S.) 1, 9, p. 3; Stejneger and Barbour 1917, Check List, p. 19; Dunn 1918, Bull. Mus. Comp. Zoöl. 62, p. 467; Stejneger and Barbour 1923, Check List (2), p. 16.

1832 *Spelerpes lucifuga* Rafinesque, Atlantic Journ. 1, pp. 22, 63.

1870 *Spelerpes longicaudus* Cope, Amer. Nat. 4, p. 401; Butler 1888, Journ. Cincinnati Soc. Nat. Hist. 10, p. 147.

1890 *Gyrinophilus maculicaudus* Cope, Amer. Nat. 24, p. 967 (Brookville, Ind.); Butler 1892, Journ. Cincinnati Soc. Nat. Hist. 14, p. 170.

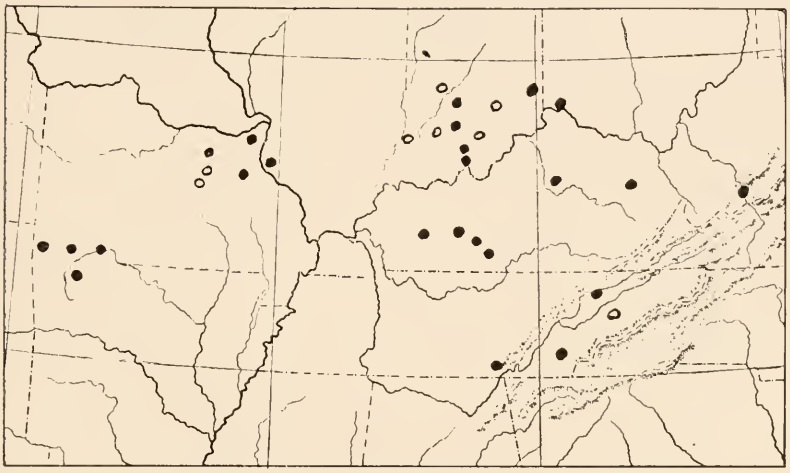
1891 *Spelerpes maculicaudus* Hay, Amer. Nat. 25, p. 1133; 1892, Rept. Dept. Geol. Indiana 17, p. 447, pl. 1, f. 4; Cope 1894, Proc. Acad. Nat. Sci. Philadelphia, p. 383; Gaines 1895, Amer. Nat. 29, p. 55; Eigenmann 1901, Trans. Amer. Micr. Soc. 22, p. 189, pl. 27; Hurter 1903, Trans. Acad. Sci. St. Louis 13, 3, p. 79; Eigenmann and Kennedy 1903, Biol. Bull. 4, p. 227 (melanism); Banta and McAtee 1906, Proc. U. S. Nat. Mus. 30, p. 67 (habits); Banta 1907, Carnegie Inst. Publ. 67, p. 22; McAtee 1907, Proc. Biol. Soc. Washington 20, p. 14; Hahn 1908, Proc. U. S. Nat. Mus. 35, p. 555; Eigenmann 1909, Carnegie Inst. Publ. 104, p. 28, pl. 1, ff. B. Bb; Hurter 1911, Trans. Acad. Sci. St. Louis 20, 3, p. 86; Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 20; Steiner 1921, Anat. Anz. 53, p. 513, f. 9 (tarsus).

1897 *Spelerpes maculicauda* Blatchley, Rept. Dept. Geol. Indiana (1896), p. 125; Eigenmann 1900, Pop. Sci. Month. 56, p. 474, f. 1.

Type: Not known to exist.

Type locality: "Cave near Lexington, Ky."

Range: From Barger's Spring, W. Va., and Marion Co., Tenn., to Cincinnati, Ohio, Mammoth Cave, Ky., Carroll Co., Ark., and Jasper Co., Mo. Inhabits the Cumberland and Kanawha plateaus, the central lowland and the Ozark region. A specimen from Augusta, Ga., U. S. N. M. 8803, may be for the present, regarded as incorrectly labeled. A larva, M. C. Z. 225, from "Alabama" probably indicates that, as might be expected, it ranges into that state along the Cumberland plateau.



54. Middle States, showing localities for Eurycea lucifuga.

Diagnosis: A *Eurycea* with 14-15 costal grooves; red ground color; rather long angular vomerine series; 5 toes; a long tail; pigment in rather scattered spots; male with cirri.

Description: M. C. Z. No. 1679, adult male; Haunted Cave (near Mammoth Cave), Ky.; costal grooves 15; appressed toes just meeting; head width 6 in length from snout to vent; head length 3⅓ in length of body; head oval; snout swollen; eye as long as its distance from tip of snout; sides of naso-labial groove swollen and prolonged into a cirrus whose tip is free from lip; outline of upper jaw straight as

viewed from side; angle of jaw below hind angle of eye; a short groove from angle of jaw to groove of lower lid; hind part of lower lid with a groove into which upper fits so that part of lower is prolonged backwards spur fashion; a groove from eye along side of head to gular fold; latter on side of neck to level of insertion of arm; limbs long; fingers 3, 2, 4, 1 in order of length; toes short, 4, 3, 2, 5, 1 in order of length; tail much longer than head and body, subquadrate at base, slightly flattened at tip; anus with lips lined with papillae; vomerine teeth 15 in series, beginning behind inner edge of the small nares, running forwards and inwards to level of middle of nares, and then backwards and inwards (making an obtuse angle), to level of middle of eyesocket, separated from its fellow by length of outer arm and from parasphenoids by length of inner arm; parasphenoids in two patches beginning at level of hind edge of eyesocket; orange red, an irregular row of black spots the size of the pupil from eye above insertion of legs to level of vent; between these rows and on back and sides of tail and on upper surface of limbs similar but smaller spots; ventral surface immaculate; head 15, body 50, tail 85, total length 150.

Variation: A female, M. C. Z. 1465; Diamond Cave, Ky.; has 14 costal grooves; head length 3 times in length of body; lip swollen below nostril but no cirrus; tail keeled above in distal two-thirds; anal lips smooth; vomerine series separated from parasphenoids by length of outer arm of vomerines; color generally similar to that of described male but with no distinguishable lateral rows of spots; total length 152, head 17, body 55, tail 80.

The usual costal groove count is 14, one costal fold occasionally separates the appressed toes. A young specimen, M. C. Z. 2778, from Jefferson Co., Mo., has a median dorsal row of spots and a lateral row on each side, the sides of the tail are spotted but the dorsal surface is immaculate; total length 70, head 8.5, body 28, tail 33.5.

A larva, M. C. Z. No. 7343, Osceola, Greenburg, Ky., shows appressed toes separated by less than one costal fold; a broad dark lateral band with indefinite borders above and below; three rows of larval areas present, the middle most indistinctly; upper row of quite small dots although the dorsal region is already lighter than the sides; total length 46, head 5, body 22, tail 19.

Largest male	164	16.5	53.5	94	U. S. N. M. 27491	Barger's Spg., W. Va.
Largest female	167	15	57	95	U. S. N. M. 57108	Morgan Co., Ky.

Largest larva	58	6.5	24.5	27	U. S. N. M. 57114	Stone Co., Mo.
Smallest adult	56	7	21	28	U. S. N. M. 36228	Bloomington, Ind.
Smallest larva	18	2.5	8.5	7	U. S. N. M. 36235	Bloomington, Ind.

Habits: Banta and McAtee (1906) have published a life history of this salamander as it is found in Mayfield's Cave, near Bloomington, Indiana. They say "It is most commonly found in caves, and as a rule occurs at no great distance from the mouth, usually barely beyond twilight." "It sometimes ventures into the deeper recesses, however, being reported from a spot 1½ miles within Wyandotte Cave, and it regularly resorts to such places to lay its eggs." But Blatchley (1898) records two specimens beneath logs in Monroe Co., Ind., a mile or more from any known cave and half that distance from springs or streams, and Hurter (1911) says that in Jefferson Co., Mo., he found them plentiful near Pevely "near springs originating in the limestone formation, but there is no cave in the whole neighborhood. They are generally found under slabs on the side of gullies." To continue the account of Banta and McAtee, "The larvae are hatched and develop in deeper fastnesses." "The younger larvae occur in the remoter parts. After and even before transformation there is a gradual movement towards the mouth." "The adults are generally found in a crevice or upon a shelf of the wall. They are great climbers." "The process of mating has not been observed nor have the eggs been seen. The larvae have first been found about February 5th and are at this time slightly under 18 mm. in length." Some transform in the autumn, but most "mature later, twelve to fifteen months after their appearance in the cave." They give an account of the metamorphosis of two individuals, one of which was nearly complete on May 1 and the other on January 30. The development of the color pattern and the part played therein by the larval areas was worked out by McAtee in the same paper. This is comparable with that of *E. bislineata bislineata* (q. v.) but here after the pattern is marked out it breaks up and the adult is marked irregularly. Hahn (1908) mentions their eating flies.

Remarks: I have included in the synonomy a reference by Cope (1870) to an "orange colored S. *longicauda*" from a cave in Jefferson Co., Tenn.

This species is the most advanced of the genus in color pattern. The larval areas have lost their influence on the adult pattern. In *Pseudotriton* and *Gyrinophilus* the larval areas have no influence be-

cause they are small and do not change in size nor attract pigment. But in *E. lucifuga* the larval areas go through the same stages as in the other Euryceas producing a pattern whose salient feature is a light dorsal stripe, and then the whole affair breaks down and the pigment distribution of the adult bears little resemblance to any such pattern. In other characters also it stands alone. Red ground color instead of yellow, short toes, and long angular vomerines are possessed by it and by no other *Eurycea* and while these are not necessarily specialized characters, there is no linking *E. lucifuga* to any of the other species and it stands isolated in the genus and perhaps its latest development.

This is the cave salamander of Rafinesque. Like many another good species of that unfortunate author it has spent an unconscionably long time in the synonomy.

Specimens seen 148, as follows:

Ohio: Cincinnati 1 (U. S. N. M. No. 8847).

West Virginia: Barger's Spring, Summers Co. 2 (U. S. N. M. No. 27491, 33611).

Kentucky: Morgan Co. 1 (U. S. N. M. No. 57108); Diamond Cave near Glasgow Junction 1 (M. C. Z. No. 1465); Lexington 3 (M. C. Z. No. *2271*); Mammoth Cave 4 (U. S. N. M. No. 24493, 25306-7, A. N. S.); Haunted Cave, Edmonson Co. 3 (M. C. Z. No. 1464, 1679); Bee Spring 3 (M. C. Z. No. *995, 4496, 4557*); Baker's Furnace 7 (M. C. Z. No. 1110, U. Mich. No. 53016); Osceola-Greenburg 1 (M. C. Z. No. *7343*).

Tennessee: Union Co. 1 (U. S. N. M. No. 8821); Matlock Springs near Athens 7 (U. S. N. M. No. *21134-6, 21138-41*); Winehouse Cave near Shellmound 1 (U. S. N. M. No. 29664); Nashville 2 (E. R. D.).

Georgia: Augusta ? (U. S. N. M. No. 8803).

Alabama: No locality 1 (M. C. Z. *225*).

Indiana: Crawford Co.: Wyandotte 1 (M. C. Z. No. 7061); Little Wyandotte Cave 6 (U. S. N. M. No. 19616, 24489-92, Cornell No. 1345); Sibert's Cave 5 (Brooklyn Mus. No. 1253); no locality 1 (M. C. Z. No. 7060); Marengo 13 (Field Mus. No. *3007*, 1842); Monroe Co.: Bloomington 1 (U. S. N. M. No. 17971); Mayfield's Cave 24 (U. S. N. M. No. *36215-38*); no locality 1 (M. C. Z. No. 7064); Franklin Co.: Brookville 5 (A. N. S. No. 10579-81 TYPES of *maculicaudus*, U. S. N. M. No. 17262-3); White River 1 (M. C. Z. No. 4276); White's Cave 1 (U. S. N. M. No. 25312); Lawrence Co.: Mitchell 4 (Field Mus. No. 512); Mitchell Cave 2 (U. Mich. No. 53252); Donnelson's Cave 3 (M. C. Z. No. 7063-4, 7057).

Illinois: Monroe Co. 1 (U. S. N. M. No. 57107).

Missouri: St. Louis Co. 1 (S. C.); Franklin Co. 2 (U. S. N. M. No. 57110, 57128); Jefferson Co. 15 (Cornell, Field, M. C. Z. No. 2778, 3147, U. S. N. M. No. 35650-1, 38783-5, 57115-9); McDonald Co. 2 (U. S. N. M. No. 57129-30);

Barry Co.: Gadd's Hollow 1 (U. S. N. M. No. 19775); no locality 1 (U. S. N. M. No. 18023); Stone Co.: Iron Spring 1 (U. S. N. M. No. 52332); Marble Cave 2 (M. C. Z. No. 2550, U. S. N. M. No. 45790); no locality 12 (Field, M. C. Z. No. 2540, A. M. N. H. No. 3089, U. Mich. 50144, U. S. N. M. No. 38795, 57111-4, *57171*, 58727-8); no locality 2 (A. M. N. H. No. 2516, 5378).

Arkansas: Carroll Co. 1 (U. S. N. M. No. 57109).

It has also been recorded from:

Cave in Jefferson Co., Tenn. (Cope 1870); Indiana: Vincennes, Knox Co. (Gaines 1895); Westport, Decatur Co. (Butler 1892); Indian Springs, Martin Co.; Porter's Cave, Owen Co.; Clifty Cave, Washington Co.; Saltpeter Cave, Crawford Co.; Donnahue's Cave, Lawrence Co. (Blatchley 1897); Kern's Cave near Bedford, Lawrence Co. (Hay 1891); Twin Caves, Lawrence Co.; Truitt's Cave, Stony Spring, Leonard's Spring, Griffey Creek, Monroe Co. (Banta and McAtee 1906); May's Cave, Monroe Co. (Hay 1891); Burksville, Monroe Co., Ill. (Hurter 1911); Missouri: Pevely, Jefferson Co.; Fisher's Cave near Springfield, Greene Co. (Hurter 1903); Wilson's Cave near Sarcoxie, Jasper Co.; Rockhouse Cave, Barry Co.; Fisher's Cave near Sullivan, Onondaga Cave near Leasburg, Crawford Co. (Hurter 1911).

HYDROMANTES GISTEL

1837 *Geotriton* Bonaparte, Fauna Italica, Fsc. 19 (not *Geotriton* Bonaparte Fauna Italica, Fsc. 1, 1832).

1848 *Hydromantes* Gistel, Naturgeschichte, p. XI (type *genei*).

Diagnosis: Tongue free all round; two premaxillae, a fontanelle; septomaxilla present or absent; maxilla normal; prefrontal absent; vomerine and parasphenoid series not continuous; internal nares a slit in prevomer; condyles sessile; atlas normal; eyes functional; no aquatic larval stage; males with swollen snout and with enlarged premaxillary (sometimes also maxillary) teeth; tail not constricted at base; toes 4-5, half webbed; terminal phalanges T-shaped; no palmar tubercles; 3 species.

Range: Sierra Nevada of California; Southeastern France and northwestern Italy; Sardinia.

Key to Species of *Hydromantes*.

A. Toes not truncate at tips, a canthus rostralis, Italy and France . *italicus* 344

A A. Toes truncate at tips, no canthus rostralis.

B. 25 teeth in vomerine series, Sardinia . . . . . *genei* 349

B B. 14-18 teeth in vomerine series, California . *platycephalus* 352

Note: Bedriaga (C. R. Int. Congr. Zoöl. 1892, p. 242) says that *Molge luschani* Steindachner (S. B. Ak. Wiss. Wien., 1891, 100, (1), p. 308) from Asia Minor is a *Spelerpes*. That he was in error Werner (S. B. Ak. Wiss. Wien., 1902, 111, (1), p. 1057), shows by his description and plate of Steindachner's species which is a *Salamandra* allied to *S. caucasica*. Therefore the two European species of *Hydromantes* seem to be the sole representatives of their family in the Old World.

HYDROMANTES ITALICUS DUNN

1837 *Geotriton fuscus* Bonaparte, Fauna Italica, fasc. 19 (not *Salamandra fusca* Laurenti, 1788, Syn. Rept., p. 42); Savi 1838, Nuovo Giorn. Litt. 37, p. 208 (not seen); Bonaparte 1840, Mem. R. Ac. Sci. Torino (2), 2, p. 451; Gray 1850, Cat. Batr. Grad. Brit. Mus., p. 47; Duméril and Bibron 1854, Erp. Gén. 9, p. 112, pl. 102, f. 1; Jan. 1857, Cenni Mus. Civ. Milano (not seen); Hallowell 1858, Journ. Acad. Nat. Sci. Philadelphia (2), 3, p. 349; de Betta 1864, Mem. Inst. Veneto 2, 3, p. 352 (not seen); Cope 1869, Proc. Acad. Nat. Sci. Philadelphia, p. 102; de Betta 1874 in L'Italia sotto l'aspetto

fis., stor., art., stat. (not seen); Wiedersheim 1875, Salamandrina perspicillata and Geotriton fuscus (anat.); Giglioli 1880 in Cat. Sez. Ital. Esp. int. Pesc. Berlin (not seen); Fischer 1892, Verh. Phys. Med. Ges. Wurzburg 25, p. 1 (anat.); Rossi 1895, Publ. R. Inst. Firenze 1, 16 (oviduct); 1895, l. c. 17 (ova); Terni 1908, Mon. Zoöl. It., 19, p. 299 (testis); 1910, Mon. Zoöl. Ital. 21, p. 169 (spermatogenesis); 1911, Arch. It. Anat. Emb. 10, p. 1 (spermatogenesis); 1912, l. c., p. 555 (mitochondria); Levi 1912, Anat. Anz. 42, p. 576 (mitochondria); Terni 1913, Arch. It. Anat. Emb. 11, p. 207 (mitochondria); 1914, Arch. f. Zell. Forsch. 12, p. 1 (mitochondria); Dunn 1918, Bull. Mus. Comp. Zoöl. 52, p. 465.

1840 *Triton fuscus* Schinz, Europaische Fauna, 2, p. 62.

1870 *Spelerpes fuscus* Strauch, Mém. Acad. Sci. St. Pétersbourg (7), 16, p. 83; Schreiber 1875, Herp. Europ., p. 86; Wiedersheim, 1877, Morph. Jahrb. 3, pl. 3, f. 45, pl. 7, f. 108 (skull); Lataste 1878, Rev. Int. Sci. 2, p. 494; Reguis 1882, Essai hist. Nat. Vert. Provence (not seen); Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 69; Mueller 1882, Verh. Ges. Basel 7, p. 212; Lessona 1883, Mem. Ac. Sci. Torino (2), 34, p. 125 (skin); Camerano 1884, Mem. R. Ac. Sci. Torino (2), 36, p. 412; Sacco 1885, Atti. Ac. Torino 20, p. 86; Peracca 1885, Atti. Ac. Torino 20, p. 827; Rudinger 1885, Sitz. Bayerische Ak. Wiss. 15, p. 109 (tongue); Camerano 1885, Atti. Ac. Torino 20, p. 793; Mueller 1887, Verh. Ges. Basel 8, p. 250; Rossi and Vicarelli 1890, Mon. Ital. Zoöl. 1, p. 222 (oviduct); Rossi 1890, Giorn. Med. Speri. (egg neucleus; not seen); Berg. 1893, Zoöl. Gart. 34, p. 367 (habits); Camerano 1894, Atti. Ac. Torino 29, p. 705 (lack of lungs); Berg 1896, Zoöl. Gart. p. 88 (habits); Bedriaga 1897, Bull. Soc. Imp. Nat. Moscou, N. S., 10, p. 49; Murray 1897, Anat. Anz., 13, p. 661 (vertebrae); Bethge 1898, Zeitschr. Wiss. Zoöl. 63, p. 680 (circ. syst.); Benidicenti and Polledro 1899, Atti. Ac. Lincei Rend. (5), 8, p. 413 (cutaneous poison); Goggio 1903, Atti. Soc. Toscani Sci. Nat. 13, p. 100 (respiration); Szamoylenko 1904, Freiburg i. Baden (28) (tongue; not seen); Ballowitz 1906, Anat. Anz. 28, p. 237 (testis); Aggrazotti 1910, Zeitschr. Allg. Phys. 11, p. 249 (mitochondria); Schreiber 1912, Herp. Europ. (2), p. 23; Schmalz 1916, Blätt. Aquar. Terr. 27, p. 282 (habits); 1918, t. c. 29, p. 35 (habits); Phisalix 1918, Bull. Mus. Paris 24, p. 92 (cutaneous poison); Procter 1920, Proc. Zoöl. Soc. London, p. 437 (breeding); 1921, Ann. Mag. Nat. Hist. (9), 7, p. 222 (prehensile tail); Mertens 1923, Blätt. Aquar. Terr., 34, 7, p. 1.

1880 *Spelerpes (Geotriton) fuscus* Lataste, Le Naturaliste, 37, p. 289; Fischer 1887, Zoöl. Gart. 28, (2), p. 33 (habits); Terni 1909, Mon. Zoöl. Ital. 20, p. 296 (testis);

1923 *Hydromantes italicus* Dunn, Proc. New England Zoöl. Club, 8, p. 40 (substitute name).

Note: *Salamandra savii* Gosse in Cuvier, Regne Animal (2), 2, p. 115, 1829, is a synonym of *Salamandra perspicillata* Savi, although Bonaparte quoted it in the synonymy of his *Geotriton fuscus* 1837.

Type: Not known to exist.

Type locality: Apuan Alps and Apennines.

Range: From Nice, France, to Fiesole, Italy.

Diagnosis: A *Hydromantes* with 11-12 costal grooves, vomerine series of 12-18 teeth, toes bluntly pointed at tips, head not flattened, a canthus rostralis.

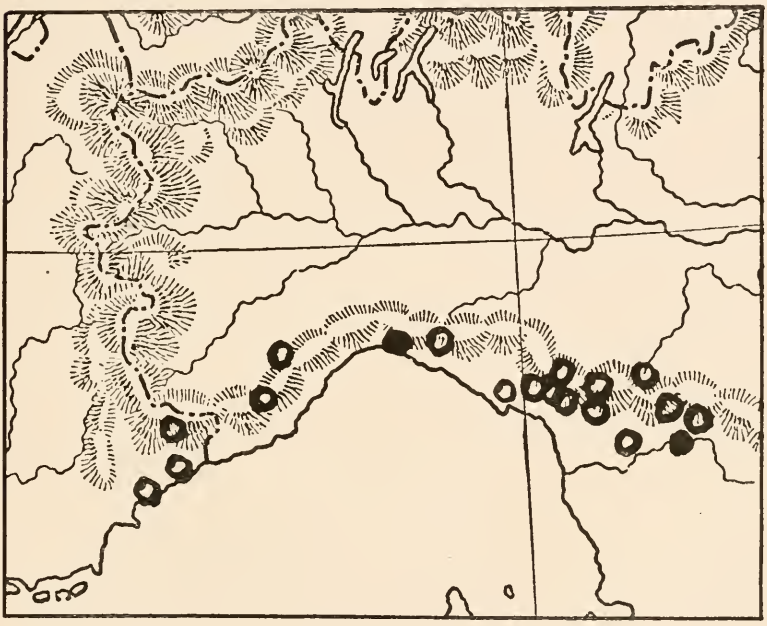
Description: M. C. Z. 1944, adult female; Genoa, Italy. Costal grooves 12, one costal fold between appressed toes; head width 5½ in length from snout to vent; head length 3⅜ in length of body; snout not swollen; eye as long at its distance from tip of snout; head oval from above; outline of upper jaw straight as seen from side; a somewhat blunt canthus rostralis; upper eyelid fitting over lower in front and behind; a groove from eye back to gular fold; from this a groove down behind angle of jaw; latter back of hind angle of eye; limbs well developed; fingers 3, 2, 4, 1 in order of length, web to next to last joint of 3; toes 3, 4, 2, 5, 1 in order of length, web to next to last joint of 3; toes and fingers not flattened, enlarged and bluntly pointed at tips; tail circular in cross section not constricted at base, shorter than body; anal lips smooth; vomerine tooth series consisting of about 12 teeth, beginning outside of nares, curving in and back, separated from its fellow by the width of the nares, from the parasphenoids by four times that distance; latter in two well separated patches beginning opposite last third of eyesocket; color purplish brown, lighter below; irregularly scattered with unpigmented blotches on sides and back of body and tail, on sides of head and on entire under surface; palms and soles white; these blotches are largest on the sides; total length 109, head 16, body 54, tail 39.

Variation: A male, U. S. N. M. 14855, Fiesole, Italy, has 11 costal grooves; appressed toes overlapping; head width 4½ in length from snout to vent; head length 2 6/7 in length of body; head somewhat flattened; snout swollen; lower eyelid with groove behind into which upper fits so that part of lower is prolonged backwards spur fashion; anal lips lined with papillae; teeth on maxilla slightly larger and somewhat less in number than those in the described female; teeth on premaxilla two, enlarged, piercing lip separately, and in view when mouth is closed; color similar to that of described female, but light blotches on body forming two quite definite rows, whereby the darker, less blotched, sides are marked off from the lighter, more blotched, dorsal

region; a light blotch in upper arm and on thigh; total length 87, head 14, body 40, tail 33.

A young specimen U. S. N. M. 58733 from Italy has the toes meeting on the sides, and the diameter of the nostril is fully three times that of the nostril of the described female. Total length 30.5, head 5.5, body 15, tail 10.

The vomerine teeth may number 18 in a series. In nearly all the specimens the toes meet on the sides. These specimens are the largest



55. France and Italy, showing localities for Hydromantes italicus.

adults and smallest young I have seen. Sacco (1885) records a female from Piedmont 110 mm. long and Camerano's (1884) largest male was 100 mm. long. Bedriaga's (1897) smallest specimen was 24 mm. long. Berg's (1896) new-born measured 36 mm. so that there must be considerable variation in the size at which they emerge. The female seems to attain a larger size than the male as in most *Œdipus*. Bedriaga (1897) says that the sexes can be distinguished by certain

differences in the shape of the base of the tail. I have not been able to see these differences in my small series, but the sexes are easily told apart, as in all this group, by the presence in the male of papillae on the cloacal walls, a swollen snout, and enlarged premaxillary teeth.

Remarks: In general this seems to be more primitive than either the Californian or the Sardinian species. The last two have points in common which *fuscus* lacks, eg., 13 costal grooves, a longer vomerine series, abruptly truncated toes, and flattened head.

Habits: Although the papers of J. Fischer (1887), Berg (1893, 1896), and Bedriaga (1897), give very excellent accounts of the habits of the animal as observed in terraria, the latter alone has written on the habits in the field. He says it lives usually in mountain caves, "here they lead a monotonous existence, crouching in crevices or climbing on the vertical surfaces of rocks. These hiding places they leave only rarely in the daytime and then during rains; with the approach of night, however, they become lively and begin their wanderings so that only at this time or early in the morning can they be collected. The experienced collector who knows the localities then goes to the cave, lantern in hand, to take the animals from the face of the cliffs. Small scorpions and beetles serve as their nourishment. Their time of principal activity is in March, April and October, although, wind and weather permitting, if it has rained many days in succession, they come out of their holes in February and September also, but in midsummer they do not stir out and live on worms and light-avoiding insects in the caves." He gives descriptions of some collecting trips into two caves in Piedmont, Garessio and Ponte de Nava. The animals were very slow and deliberate in their movements. In terraria they enter the water before shedding the skin, stay in for a day or two and shed the skin on emerging. The males deposited spermatophores on the ground in October. The tongue can be protruded 40 mm. The first observations of the young were made by Berg (1896), who had five young born on dates ranging from March 28 to July 8. He was unable to observe the parturition or determine the mother. A second observation was made by Miss Procter (1920) on May 8.

Specimens seen, 16, as follows:

Italy: Genoa 1 (M. C. Z. No. 1944); Florence 3 (U. S. N. M. No. 37170, 39271-2); Fiesole 4 (U. S. N. M. No. 14855); Piedmont 2 (A. N. S.); no definite locality 6 (U. S. N. M. No. 7409, 58731-3, A. N. S.).

It has been recorded from the following additional localities:

France: Mont Agel, near Mentone, Mt. Leusa, near Nice (Bedriaga 1897); St. Martin de Vesubie, 1800 m., (Lataste 1878); St. Martin de Lantosque, 1800 m., (Lataste 1880).

Italy: Piedmont: Cave on Mt. Armetta, near Ormea; cave near Garessio (Bedriaga 1897); Ormea to Nava (Peracca 1885); cave on R. Roburentello near Nasi (Sacco 1885).

Liguria: Spezia (Weissman 1876); Nervi (Jan. 1857); Grotto of Ponte di Nava (Bedriaga 1897).

Emilia: Mt. Sambuca near Bagni de Poretta (Bonaparte 1837).

Tuscany: Massa, Carrara, Saravessa (Bonaparte 1837); Cercina near Florence (Mueller 1882); Abetone, Garfagnana, Montecatini, Pratolino (Giglioli 1880); Bagno di Lucca (Mueller 1887).

Hallowell's (1858) record for Spain is undoubtedly erroneous.

HYDROMANTES GENEI (SCHLEGEL)

1838 (Sept.). *Salamandra genei* Schlegel, Fauna Japonica, Rept., p. 115; 1839 Abbildung. Amphib., pl. 39, f. 5-7; Kuster 1844, Isis, p. 635.

1838 (Oct.). *Geotriton genei* Tschudi, Mém. Soc. Sci. Nat. Neuchâtel, p. 59, pl. 2, f 3.

1923 *Hydromantes genei* Dunn, Proc. New England Zoöl. Club 7, p. 40.

1839 *Geotriton fuscus* Gene, Mém. Roy. Acad. Sci. Torino (2), 1, p. 27; Caruccio 1870, Atti. Soc. Italiano Sci. Nat. 12, p. 567; Giglioli 1880, in Cat. Sez. Ital. Esp. int. Pesc. Berlin (not seen).

1878 *Spelerpes fuscus* Mueller, Verh. Ges. Basel 6, p. 579; Camerano 1884, Mem. R. Ac. Sci. Torino (2), 36, p. 412; Boettger 1892, Kat. Batr. Senck. Mus., p. 60; Lampe 1911, Jahrb. Nassau Ver. Nat. 64, p. 225; Dehaut 1920, Vie Vertebre Insulaire, p. 59; Mertens 1923, Blätt. Aquar. Terr. 34, 7, p. 1.

Type: In Leyden Museum(?). Collected by Cantraine.

Type locality: Sardinia.

Range: Island of Sardinia.

Diagnosis: A *Hydromantes* with 13 costal grooves; very long vomerine series, 25 teeth; toes with terminal phalanges longer than in *H. fuscus* and abruptly truncate; no canthus rostralis but head not markedly flattened.

Description: M. C. Z. 2166, adult female; Sardinia; costal grooves 13; appressed toes overlapping; head width 5 in length from snout to vent; head length 2⅝ in length of body; head oval from above, eye as long as its distance from end of snout; snout not swollen; outline of upper jaw straight from side; no canthus rostralis; upper eyelid fitting over lower in front and behind; a groove from eye to gular

fold; a groove from this down behind angle of jaw; latter back of hind angle of eye; limbs well developed; fingers long, flat, and broadly truncate at tips, 3, 2, 4, 1 in order of length, web to next to last joint of 3; toes long, flat, and truncate at tips, 4, 3, 5, 2, 1 in order of length, web to next to last joint of 3; tail circular in cross-section, not constricted at base, shorter than body; anal lips smooth; vomerine teeth about 25 in series, beginning outside outer border of nares, curving in and back, separated from its fellow by a gap no greater than exists between two teeth of the same series, meeting its fellow at an acute angle, separated from parasphenoids by ½ the length of the series; latter in two well separated patches beginning opposite posterior quarter of eyesocket; purplish brown mottled with darker brown; below light with gray mottling, especially on the throat; total length 110, head 18, body 51, tail 41.

Mertens (1923) says of the color of live specimens from Tortoli. "in opposition to the numerous mainland specimens, which I have formerly had opportunity to observe, these cave salamanders looked very different; among other things I was struck by the entire lack of brown or red-brown tones in these Sardinians; their coloration gave an olive-green impression."

He had a "wonderfully beautiful green" young one 26 mm. in length, on its arrival in May, 1922. "On October 22 the young *Spelerpes* had already a length of 41 mm., on February 10 one of 48 mm., and at the beginning of April, although apparently scarcely a year old, it reaches 54 mm." "Especially remarkable on this young *Spelerpes* were the . . . large nostrils. It seems indeed . . . as if the nostrils shrink rather than grow with the growth of the young *Spelerpes*. They seem really much smaller in my yearling than when I got it a year ago. Also the little swellings under the nostrils . . . were in my young beast much larger. They are as much developed in grown females as in males."

Habits: Gene (1839) says, "under stones in mountains near Iglesias;" and "I found a young one in the stomach of a *Natrix Cettii.*" Kuster (1844) says, "under stones in a shady place." Weissmann (1876) says, "I learn from Dr. Wiedersheim that in Sardinia it æstivates from June until winter."

Mertens (1923) gives an account of three specimens in a terrarium. "In June, July, and August, I got nothing especial to see of my

Spelerpes. They seem to perform a sort of æstivation. In September they appeared . . . regularly in the evenings. They crawled slowly around on the glass walls of the tank, and they apparently spent the nights outside of their hiding places. Not seldom I found them still on the glass walls in the early morning. In November (my salamander tanks were in an unheated room) the cave salamanders disappeared entirely into their hiding places. Not until the beginning of March did I see my cave salamanders again in a good position.

"On April 10, 1923, a few minutes after eleven in the morning, I noticed that my brighter colored beast was meddling with the larger (almost 100 mm. long) but somewhat duller one. The first I took from the beginning to be a male, the latter was to all appearance a female. The latter lay hidden among moss most of the time; only the head and the end of the tail (which kept up peculiar waving and writhing movements, perhaps tactile) visible. The male began to rub with his head first the tail and then the head of the other animal. When, a few minutes later, she crept out of her hiding place, the male climbed on her back, his head lying over the head of the female. He embraced the female with his arms right back of her armpits; body and tail were closely appressed to hers; both beasts then began to wave their tails in a lively fashion. The female had the energy to crawl forward; the male on her back was carried along so for a short distance. After about 3-4 minutes the male released the female; then it came back again. Then he sought the back of the female again, and this time embraced the neck in front of the arms. The peculiar snaky tail movements of the beasts, especially of the female, were seen again. This time also the male did not remain long on the female. As she crept up on the glass wall of the tank, the male followed and tried to climb on her there, in which he succeeded. With the male on her back the female could not cling to the glass, and fell with her burden to the floor, where she broke loose from the male, and, apparently frightened, swiftly sought her accustomed hiding place, a narrow hollow under a flat stone. The male crept back on the glass wall, where he stayed quietly. This Liebespiel lasted not longer than 15 minutes."

Remarks: Kuster (1844) seems to have been the first to remark on the differences between the Italian and the Sardinian forms. The

characters he mentions are quite noticeable and it is surprising that others have not apparently remarked them.

Specimens seen 1, as follows:

Sardinia: No definite locality 1 (M. C. Z. No. 2166).

It has been recorded from Iglesias (Gene 1839); Nurri (Kuster 1844); Barbagia (Giglioli 1884); Luras (Camerano 1884); Sassari (Boettger 1892); Lanusei (Lampe 1911); Aritzo and Orgosolo (Dehaut 1920); Tortoli (Mertens 1923). Its range seems to cover the island.

HYDROMANTES PLATYCEPHALUS (CAMP)

1916 *Spelerpes platycephalus* Camp, Univ. California Publ. Zoöl. 17, p. 11; f. 1-5; Grinnell and Camp 1917, t. c., p. 132, f. 2.

1917 *Eurycea platycephala* Stejneger and Barbour, Check List, p. 20; Grinnell and Storer, Animal Life in the Yosemite, p. 652, pl. 60, f. f.

1923 *Hydromantes platycephalus* Dunn, Proc. New England Zoöl. Club 8, p. 40; Stejneger and Barbour, Check List (2), p. 17.

Type: Mus. Vert. Zoöl. Univ. California No. 5693, adult female, collected by C. L. Camp, July 18, 1915.

Type locality: Head of Lyell Canon 10,800 feet altitude, Yosemite National Park, California.

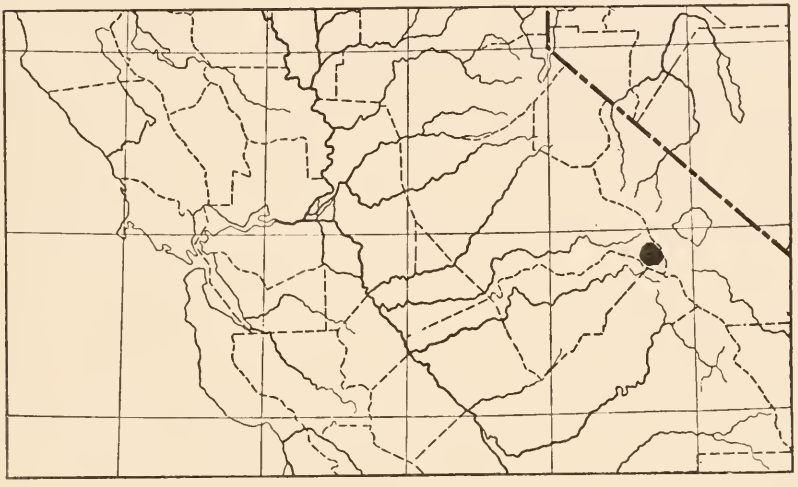
Range: Known only from the type locality.

Diagnosis: A *Hydromantes* with 13 costal grooves, vomerine series of 14-18 teeth, no canthus rostralis, head markedly flattened, toes truncate at tips.

Description: Adult female, Mus. Vert. Zoöl. U. Cal. 5693; Lyell Canon, 10,800 feet, Cal.; 13 costal grooves; 2 costal folds between appressed toes; head width 5⅞ in length from tip of snout to vent; head length 3⅗ in length of body; snout not swollen; eye longer than its distance from tip of snout; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; upper eyelid fitting over lower in front and behind; a groove from eye back to gular fold; limbs well developed; fingers 3, 2, 4, 1 in order of length, webbed at base; toes 3, 2, 4, 5, 1 in order of length, webbed to next to last joint; toes and fingers not flattened, enlarged at tips; tail circular in cross section, not constricted at base, shorter than body; anal lips smooth; vomerine tooth row not connected with parasphenoids, about 14 teeth in series, beginning beyond nares, curving in and back, separated

from its fellow by the width of the nares, from the parasphenoids by twice that distance; latter in two well separated patches diverging posteriorly, beginning opposite middle of eyesocket. "Color in life dark chocolate, marked evenly and thickly on back and sides of head and body, on limbs, feet and tail and below chin with lichen-like gray markings, yellowish in tinge down middle of back, where less distinct and bluish on sides; under parts posterior to gular fold uniform dark chocolate." These "lichen-like" markings are more numerous and run together on the sides in a sort of dorsolateral stripe.

Total length (in life) 106.5, head 15.3, body 55.7, tail 35.5.



56. California, showing locality for Hydromantes platycephalus.

Variation: A male, Mus. Vert. Zoöl. U. Cal. 5694, same locality, differs in having the appressed toes separated by one costal fold; head width 4⅞ in length from tip of snout to gular fold; head length 3½ in length of body; snout more swollen; 18 teeth in vomerine series, which is separated from its fellow by less than half width of nares and from parasphenoids by three times width of nares; teeth on upper jaw very long and narrow, reduced in number (7 on right maxilla), protruding below the lips on sides (not piercing lip).

Color more obscure than the female, but similar and giving the impression of a dorsolateral light band.

Total length 86.9, head 12.6, body 44.1, tail 30.2.

Habits: The two specimens known were caught "simultaneously in a spring-clip mouse-trap set in front of a small hole running into the moist soil beneath some rocks." The locality was "about a mile from the glacier and a little below timber line in a little patch of heather. A stream close by issued directly from the snow banks and disappeared beneath rock slides below."

Remarks: In habit, coloration, dentition, skull characters, lack of basal constriction of tail, webbing of toes, and expansion of the terminal phalanges this animal shows its relationship with *Hydromantes genei.* The sexual dimorphism is different and indeed unique. Yet traces of a similar development may be seen in the males of *Oedipus chiropterus* of Mexico.

Specimens seen 2, as follows:

California: Lyell Canon, 10.800 feet 2 (Mus. Vert. Zoöl. No. 5693-4 TYPES).

OEDIPUS TSCHUDI

1838 *Oedipus* Tschudi, Mém. Soc. Sci. Nat. Neuchâtel, p. 58 (type *platydactylus*).
1854 *Bolitoglossa* Duméril and Bibron, Erp. Gén. 9, p. 88 (partim).
1868 (Aug.). *Oedipina* Keferstein, Nach. Ges. Göttingen 15, p. 331 (type *uniformis*).
1868 (Oct.). *Ophiobatrachus* Gray, Ann. Mag. Nat. Hist. (4), 2, p. 297 (type *vermicularis*).
1893 *Haptoglossa* Cope, Proc. Amer. Phil. Soc. 31, p. 334 (type *pressicauda*).

Diagnosis: Tongue free all round; one premaxilla, nasal spines not fused, a fontanelle; septomaxilla present or absent; maxilla normal or partly or wholly edentulous; prefrontal present or absent; vomerine and parasphenoid series not continuous; internal nares a notch in prevomer; condyles sessile; atlas normal; eyes functional; no aquatic larval stage; males usually (except in worm-like forms) with swollen snout and enlarged premaxillary (and occasionally maxillary) teeth; tail with basal constriction (except in worm-like forms); toes 4-5, webbed partly or fully, or more or less united and rudimentary; terminal phalanges T-shaped; no palmar tubercles; 30 species.

Range: Southern Mexico to Bolivia.

Key to *Oedipus:*

1. *Oedipus* of normal salamander form, not worm-like, never more than 14 costal grooves, feet and limbs never much reduced, nostrils never large in adult 2
   Oedipus of which the above is not true 21
2. Toes not fully webbed 3
   Toes fully webbed 13
3. Large species reaching 195 mm., markings not a light dorsal band, vomerine teeth 18-20 in series 4
   Medium and small species, never over 150 mm., markings usually a light dorsal band, vomerine teeth at most 15 in series . . 6
4. Toes nearly free, a double row of yellow spots, Mexico . *bellii* 357
   Toes about half webbed, no dorsal markings 5
5. Toes more webbed, no light ring at base of tail, Honduras . . . . . *schmidti* 361
   Toes less webbed, a light ring at base of tail, Costa Rica, *robustus* 362
6. Small species not over 90 mm., toes nearly free, 9 or fewer teeth in vomerine series 7

Medium species, toes usually half webbed, 9 or more teeth in vomerine series 9

7. Vomerine series very oblique, beginning at inner edge of nares, inner toe rudimentary, tail longer than head and body, eastern Mexico . . . . . *chiropterus* 368
Vomerine series more transverse, beginning outside inner edge of nares, inner toe not rudimentary 8

8. Tail shorter than head and body, western Mexico . *sulcatus* 364
Tail longer than head and body, Guatemala . . . . . *rex* 366

9. Toes nearly free, a groove from eye to gular fold, Mexico . . . . . *cephalicus* 380
Toes half or more webbed, no groove from eye to gular fold 10

10. Two phalanges of third toe free, Guatemala . . . *rostratum* 384
Less than two phalanges of third toe free 11

11. One phalanx of third toe free 12
Less than a whole phalanx of third toe free, Colombia and Venezuela . . . . . *adspersus* 393

12. Two very different color phases, one with light belly, Guatemala and Honduras . . . . . *morio* 387
No light color phase, Costa Rica and Panamá, *subpalmatus* 390

13. Belly unpigmented 14
Belly pigmented 15

14. A dorsal light area with large dark spots outlined with light, Pacific Coast, Mexico to Costa Rica . . . . . *salvinii* 405
Dark with two dorsolateral light lines, Guatemala and Chiapas . . . . . *attitlanensis* 408

15. Belly striped, yellow and blackish brown, Nicaragua and Costa Rica . . . . . *striatulus* 416
Belly not striped 16

16. Dorsal area of clear yellow, with or without black spotting or streaking, Mexico to Honduras . . . . . *platydactylus* 400
Dorsal area not of clear yellow 17

17. Large species over 150 mm. 18
Small species under 100 mm. 19

18. Legs longer, black with dirty yellowish or reddish dorsal area, Costa Rica and Panamá . . . . . *lignicolor* 410
Legs shorter, brown with ochre mottlings, Yucatan, Guatemala . . . . . *yucatanus* 413

19. No maxillary teeth 20
Maxillary teeth present, east face of Andes, Colombia to Bolivia . . . . . *altamazonicus* 396
20. A dermal ridge across head, dark with lighter streaking, Panamá . . . . . *colonneus* 420
No dermal ridge across head, a lighter dorsal area, Mexico and Guatemala . . . . . *rufescens* 418
21. Toes free or nearly so (nostrils large) 22
Toes much reduced, entirely webbed 23
22. 2-3 costal folds between appressed toes, Honduras . . *nasalis* 377
6 costal folds between appressed toes, Costa Rica . . *picadoi* 379
23. Nostrils large in adult, not worm-like 24
Nostrils not large in adult, worm-like 25
24. Teeth on maxilla, 4-5 costal folds between appressed toes, Mexico . . . . . *townsendi* 371
No teeth on maxilla, 6 costal folds between appressed toes, Mexico . . . . . *pennatulus* 374
25. Costal grooves 14, snout blunt, Mexico . . . . . *lineolus* 422
Costal grooves 17 or more 26
26. Snout blunt, eyes large 27
Snout sharp, eyes small 28
27. Costal grooves 17, Panamá . . . . . *complex* 425
Costal grooves 19, Panamá to Honduras . . . . *uniformis* 427
28. Costal grooves 17, Colombia to Panamá . . . . . *parvipes* 432
Costal grooves 19-20 29
29. Larger, maxillary teeth present, basal constriction of tail present, 19 costal grooves, Nicaragua to Panamá . . . *collaris* 430
Smaller, no maxillary teeth, no basal constriction of tail, Costa Rica . . . . . *alfaroi* 435

OEDIPUS BELLII (GRAY)

"Tlaconete," "Suchil," "Achoque de Tierra."

1849 *Oedipus platydactylus* Baird, Journ. Acad. Nat. Sci. Philadelphia (2), 1, p. 286 (not *Salamandra platydactylus Cuvier* in Gray, Griffith's Cuvier's Animal Kingdom 9, p. 107).

1850 *Spelerpes bellii* Gray, Cat. Batr. Grad. Brit. Mus., p. 46; Brocchi 1883, Miss. Sci. Mex., p. 110, pl. 206; Dugés 1896, La Naturaleza (2), 2, p. 482.

1860 *Spelerpes bellii* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 372; 1869, id., p. 105; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 68; Perez 1886, Proc. U. S. Nat. Mus. 9, p. 199; Cope 1887, Bull. U. S. Nat. Mus. 32, p. 8;

1889, Bull. U. S. Nat. Mus. 34, p. 161; Blatchley 1893, Proc. U. S. Nat. Mus. 16, p. 37; Moore 1900, Proc. Acad. Nat. Sci. Philadelphia, p. 619 (vertebrae); Günther 1902, Biol. Centr. Amer., p. 299; Gadow 1910, Zoöl. Jahrb., p. 709, 714.

1884 *Geotriton bellii* Garman, Bull. Essex Inst. 16, p. 471.

1918 *Oedipus bellii* Dunn, Bull. Mus. Comp. Zoöl. 62, p. 471.

1879 *Spelerpes belli* Cope, Proc. Amer. Phil. Soc. 18, p. 263.

1854 *Bolitoglossa mexicana* Duméril and Bibron, Erp. Gén. 9, p. 93, pl. 104, f. 2 (Oaxaca, Mex.); Dugés 1869, La Naturaleza, p. 144.

1856 *Spelerpes mexicana* Hallowell, Proc. Acad. Nat. Sci. Philadelphia, p. 11.

1854 *Salamandra togata* Valenciennes in Duméril and Bibron, Erp. Gén. 9, p. 94.

Type: In British Museum. Collected by T. Bell.

Type locality: Mexico.

Range: Mountains of South Central Mexico.

Diagnosis: An *Oedipus* with toes webbed at base, 13 costal grooves; not more than 4 costal folds between appressed toes, very long vomerine series extending beyond nares, black with a double row of yellow spots on back, parasphenoids in two patches (sometimes confluent in front); nostrils of adult small, reaching 275 mm.

Description: M. C. Z. 3931, adult male, Guerrero, Hidalgo, Mexico; 13 costal grooves; 3 costal folds between appressed toes; head width 6½ in length from tip of snout to vent; head length 3½ in length of body; head oval from above; eye a little shorter than its distance from tip of snout; snout swollen, especially below nostrils; edge of upper jaw straight as viewed from sides, turned down at angle which is back of hind angle of eye; lower eyelid fitting under upper in front, both fitting under a fold of skin behind; a groove from hind angle of eye back curving down behind angle of jaw, branching at this point and back to gular fold, latter on sides of neck to dorsal surface; limbs well developed; fingers 3, 2, 4, 1 in order of length, flat, webbed at base; toes 3, 4, 2, 5, 1 in order of length, flat, webbed at base; tail longer than body, circular in cross section, a strong basal constriction; anal lips lined with papillae; vomerine teeth not connected with parasphenoids, about 20 teeth in series, beginning outside of nares and extending nearly straight till within nares, where it curves slightly backwards, separated from its fellow by ½ width of nares and from parasphenoids by 1½ width of nares; latter in two series divided by a narrow groove, beginning in first quarter of eyesocket; 4 enlarged teeth on premaxilla emerge outside edge of lip; black above; grayish black below; a large yellow blotch on each side of head behind eye; a

V-shaped yellow spot on neck, angle forward; from the limbs of this a dorsolateral series of yellow spots on each side, one to a costal fold, 14 in all, stopping at constriction of base of tail; total length 150, head 18, body 62, tail 70.

Variation: An adult female, M. C. Z. No. 3935, same locality, has 4 costal folds between the appressed limbs, head width 7 in distance

57. Mexico, showing localities for Oedipus bellii.

from tip of snout to anus, head length about 4 in length of body, snout not so swollen, tail shorter than body, anal lips smooth, premaxillary teeth small and in line with those on maxillary. Otherwise it agrees with the male just described; total length 184, head 21, body 83, tail 80.

A young specimen, M. C. Z. No. 3933, same locality, has head width 5 in length from tip of snout to vent, head length about 3 in length of body, tail shorter than body; total length 59, head 9, body 28, tail 22.

The parasphenoid patches may be confluent in front.

	Total Length	*Head*	*Body*	*Tail*	
Largest male seen	224	27	94	103	A. N. S. 14742
Largest female	275	33	108	133	A. N. S. 14740
Smallest specimen	59	9	28	22	M. C. Z. 3933

(A. N. S., Zacualtipan, Hidalgo, Mex.; M. C. Z., Guerrero, Hidalgo, Mex.). 3 specimens from high up on Mt. Orizaba have the spots very indistinct (see Blatchley 1893).

Habits: Blatchley (1893) says, "this was the most common salamander on the slope of the mountain [Orizaba], from 8,000 to 14,000 at which latter height it was frequent beneath stones and the bark of logs."

It did not seem to be present on Popocatepetl, in the pine forest where *cephalicus* and *chiropterus* were common. Four that I found at Jalapa were taken, one in a cave under a rock, and the other three under rocks around the roots of trees in comparatively open pastures. A large male and female were caught under the same rock.

Remarks: This is perhaps the most primitive form in the genus. It has a prefrontal bone, a groove from eye to gular fold, nearly free toes, a long vomerine series, and the dorsal marking is a double row of light spots. It has no near allies, the other two large species, *schmidti* and *robustus,* being more like each other than like *bellii.*

Specimens seen 50, as follows:

Mexico: Vera Cruz: Mirador 1 (U. S. N. M. No. 12246); Orizaba, 11000 ft. 3 (U. S. N. M. No. 19263-5); Jalapa 8 (M. C. Z. No. 8434-7, A. N. S. No. 713-4, Mus. Nac. Mexico 2); Hidalgo: Guerrero 21 (U. Mich. No. 48063-4, M. C. Z. No. 3931-49); San Miguel 1 (M. C. Z. No. 3956); Zacualtipan 4 (A. N. S. No. 14740-3); Tlaxcala: 1 (Mus. Nac. Mexico); Michoacan: Patzcuaro 1 (U. S. N. M. No. 46924); Oaxaca: Mt. Zempoaltepec 1 (U. S. N. M. No. 46925); Tepic 1 (Mus. Nac. Mexico); between Chihuahua and Mexico City 2 (U. S. N. M. No. 39421-2); Gulf of California 1 (A. M. N. H. No. 2519); no locality 2 (A. N. S., U. S. N. M. No. 4063).

United States: Arizona: Ft. Whipple 3 (U. S. N. M., uncatalogued, now lost).

It has been recorded from the following additional localities:

Queretaro: Tanganzicuaro, San Juan del Rio (Dugés 1896); Guanajuato: Guanajuato (Cope 1879); Oaxaca: Putla (Boulenger 1882); Guerrero: Omilteme (Günther 1902); Jalisco: La Cumbre de los Arrostrados, Talpa, Mascota (Günther 1902); Guadalajara (Gadow 1905); Tepic: Sierra de Nayarit (Gadow 1905); Distrito Federal: Mexico City (Boulenger 1882).

Thus it has been recorded from all the states of central Mexico, except Colima, Morelos, and Puebla, and doubtless it occurs in these also.

OEDIPUS SCHMIDTI (DUNN)

1924 *Oedipus schmidti* Dunn, Zoöl. Ser. Field Mus. 12, p. 96.

Type: Field Mus. No. 4538, adult female, collected May 5, 1922, by K. P. Schmidt.

Type locality: Mountains west of San Pedro, Honduras, 2,000 feet on trail.

Range: Known only from type locality.

Diagnosis: A large *Oedipus,* with groove from eye to gular fold; feet well developed, webbed almost entirely; vomerine teeth 20, series extending beyond nares; lead gray, with indistinct black spots.

58. Honduras, showing locality for Oedipus schmidti.

Description: Type; 13 costal grooves; 3 costal folds between appressed toes; head width 4⅗ in length from snout to vent; head length 3½ in length of body; head a truncated oval as seen from above; eye longer than its distance from tip of snout; outline of upper jaw concave as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length, last joint of 3 free, rest entirely in web; toes 4, 3, 2, 5, 1 in order of length, last joint of 3

and 4 almost free, rest entirely in web; anal lips smooth; tail longer than body, terete, a basal constriction; vomerine teeth 20 in series, beginning beyond outer border of nares, running nearly straight in and then a little back, separated from its fellow by such a distance as would result from the lack of one tooth of a series, separated from parasphenoids by a little over the diameter of the nares; latter in a single patch divided posteriorly, beginning opposite anterior fourth of nares; leaden gray above, lighter below; small irregular black spots on sides of body and tail; total length 195, head 24, body 83, tail 88.

Remarks: This species seems quite close to *robustus* of Costa Rica, differing from it mainly in the greater webbing of the toes, in the presence of black spotting on the sides, and in the absence of the white ring around the base of the tail.

Specimens seen 1, the type.

OEDIPUS ROBUSTUS COPE

1894 *Oedipus robustus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 194.

1898 *Spelerpes bocourti* Boulenger, Proc. Zoöl. London, p. 478 (not of Brocchi 1883, Miss. Sci. Mex., p. 111, pl. 18, f. 2); Günther 1902, Biol. Centr. Amer., p. 301, pl. 76, f. A.

Type: A. M. N. H. No. 5464, collected by J. J. Cooper.

Type locality: Slopes of Volcano Irazu, Costa Rica.

Range: Mountains of Central Costa Rica, 1,500-5,000 feet.

Diagnosis: A large *Oedipus* with incompletely palmated toes; black, a white ring around base of tail; reaches 245 mm.

Description: M. C. Z. No. 6924, adult male; Navarro, Costa Rica; costal grooves 13; 4 costal folds between appressed toes; head width 5½ in length from tip of snout to vent; head length 3½ in length of body; head pentagon-shaped from above, nostrils at the angles; eye as long as its distance from tip of snout; snout swollen, especially below nostrils; edge of upper jaw straight as viewed from side, turned down at angle, which is back of hind angle of eye; lower eyelid fitting under upper in front, upper and lower both fitting under a fold of skin behind; a groove from hind angle of eye back, curving down to behind angle of jaw, meeting it a groove from angle of jaw backwards; gular fold only to sides of neck; limbs well developed; fingers 3, 2, 4, 1 in order of length, flat, webbed to last joint of 3, 1 completely in web; toes 4, 3, 2, 5, 1 in order of length, web to last joint of 4, 5 completely in web; tail longer than head and body, circular in

section, regularly circled by grooves, a more pronounced groove at base of tail; anus with lips lined with papillae; vomerine teeth about 18 in series, not connected with parasphenoids, beginning outside of nares and extending nearly straight till within nares where they curve slightly backwards, separated from its fellow by width of naris and from parasphenoids by twice that distance; parasphenoids in one

59. Costa Rica, showing localities for Oedipus robustus.

patch beginning at first fourth of eyesocket; 3 enlarged teeth on premaxilla emerge outside edge of lip; black with lichenous red and white pigment in scattered spots and dusted over surface, most emphasized towards tip of tail, and red on upper surfaces of humerus and femur; a white ring around base of tail, in basal constriction; total length 220, head 21, body 82, tail 117.

Variation: A female, M. C. Z. No. 6920, same locality, differs in having head width 5 in length from snout to vent; head length 4 in

length of body; tail shorter than head and body; anal lips smooth; no premaxillary fangs; total length 245, head 25, body 100, tail 120. A young specimen, M. C. Z. 6925, same locality, has 3 costal folds between the appressed toes; the head width is 5 in the length from snout to vent; the head length is 3 2/9 in length of body; there is a trace of a groove from eye to gular fold; the tail is shorter than the body; the color is generally similar to the adult but the underside of tail and belly has much white pigment; total length 69, head 9, body 29, tail 23.

Habits: All the specimens from Navarro were taken in or near dead logs or stumps.

The two adults described came from the same log. The male on the ground under a large slab which had fallen from the log, while the female was on top of the log about 5 feet above the ground in a sort of labyrinth between the bark and the wood. One young specimen was taken as he sat in a hollow, in the stump of a tree some 4 feet high and 5 inches in diameter. Another fell out of the interior of a dry stump which I kicked to pieces. They were very sluggish and while the adults wriggled a bit the young stolidly clapped their hands and feet against their bellies and lay so inert that I thought at first that they were dead.

Remarks: There is a prefrontal and a long vomerine series, but the toes are half webbed and there is no groove from eye to gular fold, nor any dorsal light marking. In this it agrees with *schmidti* from Honduras, to which it is closely allied. Günther (1902) has figured *robustus* under the name of *bocourti*.

Specimens seen 16, as follows:

Costa Rica: Irazu 1 (A. M. N. H. 5464 TYPE); Rancho Redondo 1 (M. N. C. R.); Carillo 1 (M. N. C. R.); La Palma 3 (M. C. Z. No. 5119, U. S. N. M. No. 37773-4); Navarro 10 (M. C. Z. No. 6919-28).

OEDIPUS SULCATUS (BROCCHI)

1883 ? *Spelerpes sulcatum* Brocchi, Miss. Sci. Mex., p. 112, pl. 20, fig. 2.
1924 *Oedipus sulcatus* Dunn, Zoöl. Ser. Field Mus. Nat. Hist. 12, p. 99.

Type: ? In Paris Museum, collected by Ghuisbrecht.

Type locality: Mexico.

Range: Mountains of Oaxaca, Mexico.

Diagnosis: A small *Oedipus* with short tail, toes scarcely webbed, inner not rudimentary, nostril small in adult, teeth on maxilla, vom-

erine series of about 8 teeth extending beyond nares; 1-2 costal folds between appressed toes.

Description: U. S. N. 47606, female; Cerro San Felipe, Oaxaca, Mexico; 13 costal folds between appressed toes; head width 5½ in length from snout to vent; head length 3 in length of body; head a blunt oval from above; eye longer than its distance from tip of snout; snout not swollen; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye on side of neck to gular fold;

60. Mexico, showing localities for Oedipus sulcatus.

a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length, free; toes 4, 3, 2, 5, 1 in order of length, slight trace of web at base; tail shorter than body; constricted at base, circular in cross section, anal lips smooth; vomerine teeth 8 in series, beginning outside outer edge of nares, curving in and back, separated from its fellow by twice the width of the nares, and from parasphenoids by three times width of nares; latter in two patches closely approximated in front, beginning opposite anterior third of eyesocket;

dark brown above and below, throat lighter, small irregular light spots on dorsolateral region, forming a sort of dorsolateral line on tail; total length 58, head 8.5, body 25.5, tail 24.

Variation: U. S. N. M. 47607, female, same data, has one costal fold between appressed toes; head length 2⅞ in length of body; tail shorter than head and body; vomerine series separated by width of nares and from parasphenoids by once and a half that distance; blackish above, brownish below; upper surface of tail light; upper surface of body lighter than sides, but not very distinct; on sides between insertion of legs a number of irregular white streaks running longitudinally; total length 58, head 8, body 24, tail 26.

Remarks: Nothing is known of the habits and I have seen only the two specimens described above.

I use the name *sulcatus* because it seems available. The tail is figured as quite short, and the description does not seem contradictory; Ghuisbrecht collected in Oaxaca (see Duméril and Bibron 1854). In view of the scarcity of specimens, I am unwilling to propose a new name in a case where an old one may conceivably be used. The relationships of the present form are certainly with *chiropterus* and with the longer tailed *rex* from Guatemala. In general *sulcatus* is more primitive than *chiropterus* for the rudimentary inner toes and extremely short vomerine series of the latter are not met with again in the genus save in *pennatulus* and *townsendi* which are extremely specialized forms. With the Guatemalan species it is about on a par. There is little to choose between them and they are very close although apparently distinct.

Specimens seen 2, as follows:

Mexico: Cerro de San Felipe, Oaxaca 2 (U. S. N. M. No. 47606-7).

OEDIPUS REX DUNN

1921 *Oedipus rex* Dunn, Proc. Biol. Soc. Washington 34, p. 143.

Type: Field Museum No. 1814, collected by C. M. Barbour.

Type locality: Sierra Santa Elena, near Tecpam, Guatemala; altitude 9,500 feet.

Range: Known only from type locality.

Diagnosis: A small *Oedipus* with long tail; toes scarcely webbed, inner not rudimentary; nostrils small in adult; teeth on maxilla; vomerine series of 9 teeth extending beyond nares; 3-4 costal folds between appressed toes.

Description: Field Museum No. 1814, adult male (type); Sierra Santa Elena (near Tecpam), Guatemala (altitude 9,500 feet); 12 costal grooves; 2 costal folds between appressed toes; head width 5¼ in length from snout to vent; head length 3⅓ in length of body; head a blunt oval; eye longer than its distance from tip of snout; snout swollen; a tubercle below nostrils; outline of upper jaw slightly concave as seen from side; angle of jaw back of hind angle of eye; both

61. Guatemala, showing locality for Oedipus rex.

eyelids fitting under a fold of skin behind; a groove from hind angle of eye to gular fold; a branch from this down behind angle of jaw and across throat; limbs well developed; fingers 3, 2, 4, 1 in order of length, not much flattened, webbed at base; toes not much flattened, 3, 4, 2, 5, 1 in order of length, webbed at base and between 3 and 4 to next to last joint; tail longer than head and body, constricted off at base, circular in cross-section; anal lips lined with papillae; vomerine

series not continuous with parasphenoids, about 9 teeth in series, beginning outside of nares, curving in and back, separated from its fellow by a little more than width of the very small nares, and from parasphenoids by nearly their own length; latter in two patches beginning at last third of eyesockets; two premaxillary fangs; pinkish gray dorsally and on upper surfaces of limbs and tail, shading into gray in sides of body and tail, this somewhat marbled with white, beneath light gray, white marbling on throat, light marbling on upper surface of snout; total length 89, head 10, body 33, tail 46.

Variation: A female, same data, differs in having 13 costal grooves and 3 costal folds between the appressed toes; head width 6 in distance from tip of snout to vent; snout less swollen; anal lips smooth, tail longer than head and body; 9 teeth in vomerine series which are separated from parasphenoids by half their length; color darker, lightest on throat, darkest on mid-dorsal region, but rather uniform gray all over; total length 90, head 10, body 34, tail 46. A small specimen is similar to the male but has nostrils with greater diameter than the largest specimen; total length 22, head 4, body 10.5, tail 7.5. Those described are the maximum and minimum sizes seen.

Habits: The types were taken from under logs.

Remarks: This form is not any of those hitherto described from Guatemala. Its nearest relations are with what I have called *sulcatus* from Mexico.

Specimens seen 11, as follows:

Guatemala: Sierra Santa Elena, near Tecpam, 9,500 feet 11 (M. C. Z. No. 7368-9, Field Mus. 1814 TYPES).

OEDIPUS CHIROPTERUS (COPE)

1863 *Spelerpes chiropterus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 54; 1865, id., p. 195; 1869, id., p. 106; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 67; Brocchi 1883, Miss. Sci. Mex., p. 109; Cope 1887, Bull. U. S. N. M. 32, p. 8; 1889, Bull. U. S. N. M. 34, p. 162; Dugés 1896, La Naturaleza (2), 2, p. 482; Günther 1902, Biol. Centr. Amer., p. 298; Gadow 1905, Proc. Zoöl. Soc. London, p. 203; 1910, Zoöl. Jahrb., p. 714.

1865 *Spelerpes orculus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 196 (Mexican table-land and southern mountains); Herrera 1890, La Naturaleza (2), 1, p. 340; 1892, id. 2, p. 49.

1924 *Oedipus chiropterus* Dunn, Zoöl. Ser. Field Mus. 12, p. 99.

Type: Apparently not now in existence. Collected by Sartorius.

Type locality: Mirador, Vera Cruz, Mexico.

Range: Mountains of Central Mexico.

Diagnosis: A small *Oedipus* with long tail, toes scarcely webbed save first, which is rudimentary and entirely united to the second; nostril small in adult; teeth on maxilla; vomerine series short, 7 teeth, oblique, extending only as far as nares; 3 costal folds between appressed toes.

Description: M. C. Z. 5120, adult female; Jalapa, Vera Cruz, Mexico; 13 costal grooves; 3 costal folds between appressed toes; head width 5⅔ in length of body; head a blunt oval from above; eye longer than its distance from tip of snout; snout not swollen; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; hind part of both eyelids fitting under a fold of skin; a groove from eye to gular fold; from this a groove down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length, webbed at base, 1 completely in web; toes 3, 4, 2, 5, 1 in order of length, webbed at base, 1 almost suppressed, completely in web; tail constricted at base, circular in cross section, longer than head and body; anal lips smooth; vomerine teeth 7 in series, beginning behind inner edge of nares, running straight in and back, separated from its fellow by width of nares, and from parasphenoids by its own length; latter beginning opposite hind edge of eyesocket; color brownish, a darker triangle, apex backwards, between the eyes, indications of a dark lateral band and a lighter dorsal area, throat lighter; total length 60, head 6, body 22, tail 32.

Variation: A male, U. S. N. M. 30371, Orizaba, Vera Cruz, Mexico, differs in having 12 costal grooves; one costal fold between appressed toes; head width 6 in length from snout to vent; head length 3½ in length of body; snout much swollen, especially below nostrils; outline of upper jaw sinuous from side; anal lips lined with papillae; teeth on premaxilla and forward part of maxilla much enlarged, overlapping closed mandible but not piercing lip; total length 77, head 7.5, body 26.5, tail 43. A young male, M. C. Z. 7325, Orizaba, Vera Cruz, Mexico, shows one costal fold between appressed toes, head width 5 in length of body, snout swollen and anal lips lined with papillae; the vomerines are separated from each other by ½ the width of the nares and from the parasphenoids by the width of the nares; latter begin opposite middle of eyesocket; teeth on maxilla and premaxilla similar to male described above; a dark band on sides of head, body, and

tail, darkest at upper edge which passes above insertions of legs, this band gradually fades into the somewhat lighter ventral surface of which the throat is the lightest portion, above light, a dark triangle, apex backwards, between the eyes; following this a circular dark blotch on neck and an ill-defined mid-dorsal dark band; total length 57, head 6.5, body 20.5, tail 30.

A small specimen, U. S. N. M. No. 30378, Orizaba, Vera Cruz, Mexico, has the upper surface immaculate save for the triangle between the eyes; the nostrils are nearly twice as large as those of the described adult male; total length 33, head 4, body 13, tail 16.

They may be quite dark, or with a light dorsal stripe, or quite light.

The largest and smallest specimens seen are:

	Sex	*Total*	*Head*	*Body*	*Tail*	
M. C. Z.	♂	35	7.5	27.5	0	Popocatepetl
M. C. Z. No. 8397	♀	84	7.5	32.5	44	"
M. C. Z. No. 8415	yg.	32	4	14	14	"

62. Mexico, showing localities for Oedipus chiropterus.

Habits: Dugés (1896) says that it inhabits hot countries ("tierras calidas") together with *O. rufescens,* but this scarcely fits in with Gadow's statement (1905) that he took it at from 9,000-10,000 feet on Orizaba, nor with the altitudinal range (4,000-10,000 feet) assigned to it by him in 1910; nor with Herrera's (1892) remark that around the Valley of Mexico it is "subalpine." My own experience with this form was confined to the pine forest on Popocatepetl at an altitude of 9,000-12,000 feet. There *chiropterus* was very common indeed. Its habits were much like those of *Plethodon cinereus* and it was found among decaying vegetable débris on the floor of the forest, under logs, beneath the bark of dead logs, and under any loose material.

Remarks: This species is related to and less primitive than *sulcatus* of western Mexico and *rex* of Guatemala. The reduced inner toes and very short vomerine series bespeak specialization, and together with the coloration ally it to *pennatulus,* which, however, has much reduced limbs and enlarged nostrils.

Specimens seen 49, as follows:

Mexico: Mexico: Popocatepetl 32 (M. C. Z. No. 8391-416); Vera Cruz: Orizaba 15 (U. S. N. M. No. 30370-84, M. C. Z. No. 7325); Jalapa 1 (M. C. Z. No. 5120); no locality 1 (U. S. N. M. No. 30347).

It has also been recorded from Mirador, Vera Cruz (Cope 1863); Cuernavaca and Almolonga, Morelos (Dugés 1896); Tlalpam, Mexico (Herrera 1890).

OEDIPUS TOWNSENDI DUNN

?1869 *Thorius pennatulus* Cope (color variety), Proc. Acad. Nat. Sci. Philadelphia, p. 112.

?1882 *Thorius pinnatulus* Sumichrast, La Naturaleza 6, p. 79.

1922 *Oedipus townsendi* Dunn, Proc. Biol. Soc. Washington 35, p. 5.

Type: Mus. Comp. Zoöl. No. 8017, adult male, August 20, 1921, E. R. Dunn and Prescott Townsend, collectors.

Type locality: Cerro de los Estropajos, near Jalapa, Vera Cruz, Mexico.

Range: Known only from type locality, and from Guerrero, Hidalgo. (Perhaps also from Orizaba, and from Cerro de la Defensa, near Cordoba, Vera Cruz).

Diagnosis: A small *Oedipus* with inner and outer toes rudimentary; nostrils large in adult; teeth on maxilla; vomerine series of six teeth,

not extending beyond nares; four or five costal folds between appressed toes.

Description: Type: 13 costal grooves; 5 costal folds between appressed toes; head width 5 in length from snout to vent; head length 4¼ in length of body; head a blunt oval; eye longer than its distance from tip of snout; snout swollen; nostril very large, its diameter half that of iris; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs weak; fingers 3, 2, 4, 1 in order of length, tips of third and second free, first and fourth completely in web; toes 3, 4, 2, 5, 1 in order of length, tips of third, fourth and second free, first and fifth completely in web; tail as long as head and body, constricted at base, circular in cross section; anal lips lined with papillae; vomerine series not continuous with parasphenoids, 6 teeth in series, beginning behind inner edge of nares, curving in and back to meet its fellow, from which it is separated by no more interval than exists between two teeth of the same series, separated from parasphenoids by its own length; latter in a single patch beginning at middle of eyesocket; teeth on maxilla to anterior edge of eyesocket; an enlarged tooth on premaxilla does not pierce lip; dark greenish above; black below; black V-shaped markings, apex forward, on back and on upper surface of tail; an indistinct light line on each side of back, most prominent above insertions of arms and legs; a light line across head between hind borders of eyelids; irregular white markings on sides between insertions of legs, and on sides and lower surface of tail; white dots on throat; limbs mottled black and gray; total length 42 mm., head 4, body 17, tail 21.

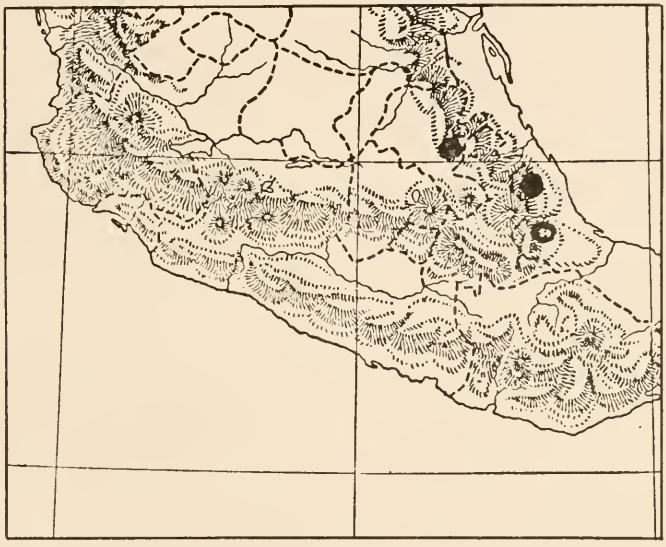
Variation: A male, M. C. Z. No. 8018, from Guerrero, Hidalgo, Mexico, has 4 costal folds between appressed toes; tail shorter than body; head width 6 in length from snout to vent; head length 3 7/10 in length of body; an enlarged tooth on premaxilla pierces lip; dull gray, lighter below; white dots on sides; a trace of lighter above insertions of arms; total length 40.5, head 5, body 18.5, tail 17.

A female, M. C. Z. No. 8020, same data as type, has head length 4 in length of body; no anal papillae; parasphenoids separated from vomerines by ⅔ length of latter; a light reddish streak from eye nearly to leg, widest above arm where it extends across back to meet its fellow of the opposite side; above this a dark streak and middle of

back light reddish with dark V's; otherwise like type; total length 36, head 3.5, body 14.5, tail 18.

Two other females, same data as type, agree with it in general: 8019, total length 40, head 4, body 18, tail 18; 8021, total length 38, head 4, body 16, tail 18. No. 8019 is filled with the yolk masses of large eggs and is fully adult.

Habits: Five were taken on the heavily wooded Cerro de los Estropajos (between Jalapa and the hamlet of San Andres, and only a few miles from the former), altitude about 5,000 feet. One was under a piece of wood on the ground and the others were under the bark of logs.



63. Mexico, showing localities for Oedipus townsendi.

Remarks: This smallest of all salamanders resembles *O. pennatulus*. Both have the unique combination of the rudimentary toes and the enlarged nostrils. But *townsendi* has teeth on the maxilla, the tail is shorter, the body is less elongate, the limbs are stouter, and the third toe has more than the last phalanx free. The coloration is quite different. The markings of *townsendi* are like those of the other *Oedipus* with enlarged nostrils, while *pennatulus* is nearly the same

as *chiropterus* which approaches it also in the weakness of the phalanges.

It is difficult to tell to which animal references pertain. Cope mentions U. S. N. M. No. 6744, as a color variety of *pennatulus* saying: "It differs in being nearly black above, in having the sides longitudinally streaked, and the gular region specked with white; a whitish incomplete triangle on the front and muzzle." No specimen with this number is now in the National collection, but an old specimen without data, No. 30352, is *O. townsendi*, and is perhaps one of Cope's originals as it was returned without data from the material borrowed by him.

Sumichrast's record from the low Cerro de la Defensa, near Cordoba possibly refers to *townsendi*.

Specimens seen 7, as follows:

Mexico: Guerrero, Hidalgo 1 (M. C. Z. No. 8018); Jalapa, Vera Cruz 5 (M. C. Z. 8017, 8019-8021); no data 1 (U. S. N. M. 30352).

OEDIPUS PENNATULUS (COPE)

1869 *Thorius pennatribus* Anon. (typ. err.), Amer. Nat., p. 222.

1869 *Thorius pennatulus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 111; Boulenger 1882, Cat. Bat. Grad. Brit. Mus. (2), p. 79, pl. 3, f. 2; Cope 1889, Bull. U. S. Nat. Mus. Bull. 34, pl. 27, ff. 2-4; Gadow 1905, Proc. Zoöl. Soc. London, p. 202.

1883 *Thorius pennatulus* Brocchi, Miss. Sci. Mex., p. 119.

1922 *Oedipus pennatulus* Dunn, Proc. Biol. Soc. Washington 35, p. 5.

?1877 *Spelerpes* sp. Wiedersheim, Morph. Jahrb. 3, pp. 427, 482, 498, pl. 21, f. 48, pl. 24, f. 87 (Vera Cruz).

?1877 *Spelerpes minimus* Wiedersheim, loc. cit., p. 544 (Vera Cruz).

Type: U. S. N. M. No. 6341 (6 specimens) and 6744 (color variety). No specimens exist at present under these numbers in the National Museum. There are, however, seven old specimens in collections which may be the types. These are: A. N. S. No. 1269 (three specimens, Orizaba, collected by Sumichrast); U. S. N. M. No. 30348-30349, 25101 (no data, returned from Cope); and U. S. N. M. No. 30352 (no data, returned from Cope, a specimen of *O. townsendi* and very possibly the "color variety" whose original number was 6744).

Type locality: Orizaba, Vera Cruz, Mexico. Collected by Sumichrast.

Range: Mountains of southern Mexico.

Diagnosis: A small *Oedipus* with inner and outer toes rudimentary;

nostrils large in adult; no teeth on maxilla; vomerine series of four teeth, not extending beyond nares; six costal folds between appressed toes.

Description: U. S. N. M. No. 47608, adult female; Cerro de San Felipe, Oaxaca, Mexico; 13 costal grooves; six costal folds between appressed toes; head width 7 in length from snout to vent; head length 4⅘ in length of body; head a broad oval from above; eye longer than its distance from tip of snout; nostril very large, diameter over half that of pupil; snout not swollen; angle of jaw under hind angle of eye; outline of upper jaw straight as seen from side; both eyelids fitting under a fold of skin behind; an indistinct groove from eye to gular fold; a groove from this down behind angle of jaw; limbs weak; fingers 3, 2, 4, 1 in order of length, united nearly to tips of 2 and 3 which alone are free; toes 3, 4, 2, 5, 1 in order of length, united to tips of 5 and 1; tail constricted at base, circular in cross section, longer than head and body, anal lips smooth; vomerine teeth 4 or 5 in series, beginning behind inner border of nares, extending nearly straight in, separated from its fellow by ⅓ its length and from parasphenoids by a distance equal to its length; latter in a single patch beginning opposite middle of eyesockets; no teeth on maxilla, 3 on premaxilla; color lead gray, lighter below, a brown dorsal stripe, tiny white dots on sides; total length 62, head 5, body 24, tail 33.

Variation: A male U. S. N. M. 30348, locality doubtful, differs in having the snout swollen, the anal lips lined with papillae; there are no teeth on the maxilla; the single tooth on the premaxilla is larger and pierces the lip.

Largest female	62	5	24	33	U. S. N. M. 47608	Cerro de San Felipe
Largest male	46	4	20	22	A. N. S. 1269	Orizaba, Vera Cruz

Habits: Gadow (1905) says of it on Orizaba, "Abundantly on the south slope, 9,000-10,000 feet, in high mixed forest, either on the ground beneath flat pieces of bark, or on decaying logs of pine between the bark and wood, amongst the boring-dust of beetles and maggots, and under exactly the same conditions on the Cerro de San Felipe near Oaxaca at 8,250 feet." "The nostrils of males are very large and open, those of females are much smaller." This sexual difference is not noticeable in the specimens I have seen.

Remarks: The relationships are with *townsendi* and with *chiropterus* and have already been discussed under the former heading. These two little Mexican forms with large nostrils are amply distinct

from the Honduran and Costa Rican species which also possess large nostrils, because the latter forms have well developed toes with little or no web, while the Mexicans have very degenerate feet, quite like those of the *parvipes* group.

Wiedersheim's tiny *Spelerpes* from Vera Cruz might be either this species or *townsendi.* The name *minimus,* which he attributes to Spengel, was never, so far as I can find, coupled with a specific description, and is therefore a nomen nudum. As it antedates *townsendi* I have thought it best to settle it in the synonymy of *pennatulus,* especially as Wiedersheim mentions some of the anatomical peculiarities which Cope found in *pennatulus* (bony carpus and tarsus) which peculiarities may or may not exist in *townsendi.*

Specimens seen 8, as follows:

Mexico: Vera Cruz: Orizaba 3 (A. N. S. 1269); Oaxaca: Cerro de San Felipe 1 (U. S. N. M. 47608); Reyes 1 (U. S. N. M. 47797); no data 3 (U. S. N. M. 25101, 30348-30349).

64. Mexico, showing localities for Oedipus pennatulus.

OEDIPUS NASALIS DUNN

1924 *Oedipus nasalis* Dunn, Zoöl. Ser. Field Mus. 12, p. 97.

Type: Field Mus. No. 4568, adult male, collected April 1, 1923, by K. P. Schmidt.

Type locality: Mountains west of San Pedro, Honduras, 4,500 feet altitude.

Range: Known only from type locality.

Diagnosis: A small *Oedipus* with nostrils large in adult; toes webbed at base; 2-3 costal folds between appressed toes.

Description: Field Mus. No. 4568, adult male; 13 costal grooves; 2 costal folds between appressed toes; head a blunt oval; head width 4⅖ in length from snout to vent; head length about 4 in length of body; snout swollen, a tubercle below nostril; nostril larger than pupil; outline of upper jaw sinuous as seen from side; angle of jaw below hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a branch from this down behind angle of jaw; limbs well developed; fingers 3, 4, 2, 1 in order of length, last two phalanges of 3 free; toes 3, 4, 2, 5, 1 in order of length, last two phalanges of 3 free; tail longer than head and body; constricted off at base, terete; anus lined with papillae; vomerine teeth 5 in series, beginning behind inner edge of nares, curving in and back, separated from its fellow by a space equalling the gap between two teeth of the same series, separated from parasphenoids by the length of a series; latter in single patch, beginning opposite middle of eye-socket; internal nares a slit; premaxillary teeth enlarged, forward, out of line with maxillary teeth; dark grayish brown; lighter on back, a dark band on sides; a dark triangle, apex backwards, base between eyes; lighter gray, dotted with white, below and on sides; two light spots on base of tail; total length 75, head 6.5, body 25.5, tail 43.

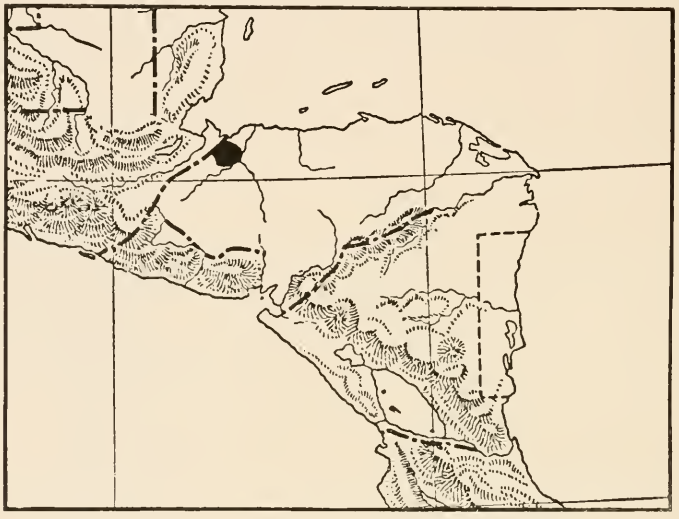
Variation: A female, Field Mus. 4579, same data, differs in having the snout not so swollen; no tubercle under nostril; anal lips smooth; vomerine teeth 8 in series, separated from its fellow by a gap equalling twice that between two teeth of the same series, separated from parasphenoids by twice that distance; total length 80, head 7, body 27, tail 46.

A young specimen, Field Mus. No. 4584, same data, has the dorsal region covered by a light reddish gray band with scalloped edges, this band contains irregular darker spots, and two lighter spots above

anus; a dark band between eyes; a dark stripe from eye to insertion of arm; total length 46, head 4, body 17, tail 25; 3 costal folds between appressed toes.

No. 4590, same data, is reddish gray above and on sides, gray below; weak and irregular dorsal and lateral dark lines; a dark stripe from eye to insertion of arm; total length 55, head 5, body 20, tail 30.

Some young have an immaculate dorsal band, and all the young are marked while most of the adults are almost uniform.



65. Honduras, showing locality for Oedipus nasalis.

Habits: The specimens were all taken from Bromeliads, some on fallen trees and others growing as high as forty feet from the ground.

Remarks: This species is closely allied to *O. picadoi* of Costa Rica, which has, however, weaker limbs, there being six costal folds between the appressed toes. The other two forms with large nostrils, *pennatulus* and *townsendi*, have the toes completely webbed.

Specimens seen 19, all from type locality:

Field Mus. 4563-4591.

OEDIPUS PICADOI (STEJNEGER)

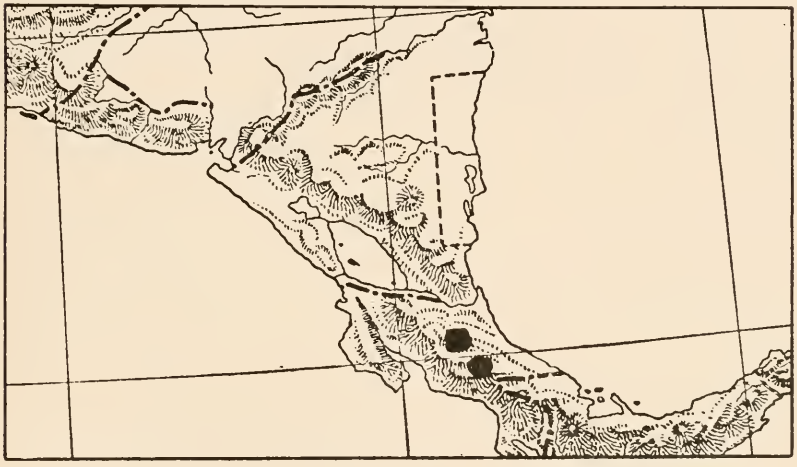
1911 *Spelerpes picadoi* Stejneger, Proc. U. S. Nat. Mus. 41, p. 285; Picado, Les Bromeliacees Epiphytes 1913, p. 342, pl. VIII, fig. 4.
1924 *Oedipus picadoi* Dunn, Zoöl. Ser Field Mus. Nat. Hist. 12, p. 99.

Type: U. S. N. M. No. 48280, collected by Senor C. Picado.

Type locality: La Estrella, S. E. of Cartago, Costa Rica.

Range: Known only from the type locality and from La Palma, Costa Rica; central mountains of Costa Rica, from 4,500-7,000 feet.

Diagnosis: A small *Oedipus* with toes scarcely webbed, inner not rudimentary, nostril large in adult, teeth on maxilla, vomerine series of 9 teeth extending beyond nares, 6 costal folds between appressed toes.



66. Costa Rica, showing localities for Oedipus picadoi.

Description: M. C. Z. No. 5125, adult female; La Palma, Costa Rica; 13 costal grooves; 6 costal folds between appressed toes; head width 6½ in length from tip of snout to vent; head length 4½ in length of body; head oval; eye longer than its distance from tip of snout; snout rather high, rounded; nostrils large, ½ size of pupil, close together in front; outline of upper jaw convex as viewed from side; angle of jaw well back of posterior angle of eye; lower eyelid fitting under upper behind and in front, both fitting under a fold of skin behind; gular fold on sides of neck to dorsal surface; limbs weak;

fingers 3, 2, 4, 1 in order of length, scarcely webbed; toes 3, 4, 2, 5, 1 in order of length, web to last joint of 2 and 5, to next to last joint of 3 and 4, and 1 nearly enclosed; tail longer than head and body, circular in cross section; anal lips smooth; vomerine teeth not connected with parasphenoids, beginning well beyond outer edge of nares curving inwards and backwards, meeting in the middle, 8-9 teeth in series, which is separated from parasphenoids by half its length; parasphenoids a single patch very pointed anteriorly, reaching level of middle of eyesockets; brownish, a light spot on back of head on each side, a light stripe between insertions of legs, a light stripe on each side of dorsal surface of tail, a black streak above light streak just anterior to insertions of legs, sides and lower part of tail marked with black, belly darker than dorsal surface, under side of limbs and throat pale.

Variation: An adult male, U. S. N. M. 37762, also from La Palma, shows larger nostrils, more swollen snout, and two premaxillary fangs; no other important variations present themselves.

Largest male	58	5	20.5	32.5	U. S. N. M. 37762	La Palma
Largest female	69	5.5	25.5	38	M. C. Z. 5125	La Palma
Smallest	18	3	15	0	U. S. N. M. 37766	La Palma

Habits: Picado (1913) says, "I have found a single individual of this Salamander. I kept it in captivity among the separated leaves of a Bromeliad. The animal lives under dead leaves and diverse detritus so as to dampen itself a little. It is a diurnal animal." He ranks it among those animals which inhabit Bromeliads. His plate is probably taken from the type.

Remarks: This is related to the Honduran *Oedipus nasalis*.

As Günther (1902) surmised, Boulenger had specimens of two species when he described *subpalmatus* in 1896. Boulenger in a recent letter assures me that upon reëxamining the types of *subpalmatus* the "small specimens" to which Günther took exception were found to be *picadoi*.

Specimens seen 7, as follows:

Costa Rica: La Estrella 1 (type, U. S. N. M. 48280): La Palma 6 (M. C. Z. 5125, U. S. N. M. 37762-37766).

OEDIPUS CEPHALICUS (COPE)

1865 *Spelerpes cephalicus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 196; 1869, id. p. 106; Sumichrast 1882, La Naturaleza 6, p. 79; Cope 1887, Bull. U. S. Nat. Mus. 32, p. 7; 1889, id. 34, p. 162.

1884 *Geotriton cephalicus* Garman, Bull. Essex Inst. 16, p. 39.
1924 *Oedipus cephalicus* Dunn, Zoöl. Ser. Field Mus. Nat. Hist. 12, p. 99.
1869 *Spelerpes leprosus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 105 (Orizaba, Vera Cruz, Mexico); Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 68; Brocchi 1883, Miss. Sci. Mex., p. 107, pl. 19, ff. 1-2; Cope 1887, Bull. U. S. Nat. Mus. 32, p. 8; 1889, id. 34, p. 162; Günther 1902, Biol. Centr. Amer., p. 200; Gadow 1905, Proc. Zoöl. Soc. London, p. 203; 1910, Zoöl. Jahrb., p. 709, 714.
1884 *Geotriton leprosus* Garman, Bull. Essex Inst. 16, p. 39.
1918 *Oedipus leprosus* Dunn, Bull. Mus. Comp. Zoöl. 62, p. 470.
1921 *Eurycea leprosus* Noble, Bull. Amer. Mus. Nat. Hist. 44, p. 3, pl. 1, f. 1, pl. 2, f. 2 (skull).
1882 *Spelerpes morio* Boulenger, Cat. Batr. Grad. Brit. Mus. (2), p. 70 (not of Cope 1869, Proc. Acad. Nat. Sci. Philadelphia, p. 103); Herrera 1890, La Naturaleza (2), 1, p. 340; 1891, id. 2, p. 46.
1883 *Spelerpes laticeps* Brocchi, Miss. Sci. Mex., p. 110, pl. 18, f. 1 (Vera Cruz).
1884 *Geotriton laticeps* Garman, Bull. Essex Inst. 16, p. 40.
1893 *Spelerpes orizabensis* Blatchley, Proc. U. S. Nat. Mus. 16, p. 37 (Mt. Orizaba, Vera Cruz, Mexico); Gadow 1905, Proc. Zoöl. Soc. London, p. 203; 1910, Zoöl. Jahrb., p. 709, 714.
1893 *Spelerpes gibbicaudus* Blatchley, Proc. U. S. Nat. Mus. 16, p. 38 (Mt. Orizaba, Vera Cruz, Mexico); Günther 1902, Biol. Centr. Amer., p. 298.

Type: Apparently no longer in existence.

Type locality: "Mexican Tableland."

Range: Mountains of South Central Mexico.

Diagnosis: An *Oedipus* with toes webbed at base; a groove from eye to gular fold; long vomerine series, 14 teeth, passing beyond nares; black with white dots (sometimes red dorsal stripe); parasphenoids in two series (sometimes incompletely separated); nostrils of adult small. Size medium, reaching 112 mm.

Description: Adult male, M. C. Z. 3916; Guerrero, Hidalgo, Mexico; costal grooves 13; appressed toes meeting; head width 5½ in length from snout to vent; head length 2½ in length of body; eye as long as its distance from tip of snout; snout much swollen, truncate in front, the angles exterior to the nostrils; a tubercle below each nostril; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; hind part of both eyelids fitting under a fold of skin; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length, a trace of web at base; toes 3, 4, 2, 5, 1 in order of length, a trace of web at base; tail constricted at base, circular in cross section, shorter than head and body; anal lips lined with papillae; vomerine

teeth 14 in series, beginning beyond outer border of nares, curving in and back, separated from its fellow by twice the width of the nares, and from the parasphenoids by the same distance; latter in two long narrow patches beginning opposite anterior quarter of eyesocket; one premaxillary tooth enlarged and piercing lip; color black, thickly covered with small irregular white dots; on belly and sides as far as insertions of legs, and on under side of tail, these dots are arranged in

67. Mexico, showing localities for Oedipus cephalicus.

groups with the black ground color showing between; on the back they are evenly spaced; total length 88, head 13.5, body 34.5, tail 40.

Variation: A female, M. C. Z. 3915, same locality, has two costal folds between the appressed toes; head width 6 in length from snout to vent, head length 3 in length of body; snout not swollen, anal lips smooth, no enlarged teeth on premaxilla, vomerine series separated from its fellow by width of nares and from parasphenoids by four times that distance; latter incompletely divided in front, beginning

opposite anterior third of eyesocket; color similar but white dots very sparse on belly below a definite line joining insertions of legs; total length 93, head 13, body 40, tail 40.

The largest male seen measured 100 mm., head 13, body 39, tail 48; and the smallest specimen was 34 mm. long, head 6, body 16, tail 12. Both were from Popocatepell.

Besides the series from Guerrero, Hidalgo, Mexico (M. C. Z. 3912-30 and U. Mich. 48061-2), U. S. N. M. 47204, a male from Pinal de Amoles, Queretaro, Mexico, belongs without doubt to the same species. I regard as conspecific:

U. S. N. M. 6340(4)	types of *leprosus*	Orizaba, V. C.
U. S. N. M. 19266-7	types of *orizabensis*	Orizaba, V. C.
U. S. N. M. 19255	type of *gibbicaudus*	Orizaba, V. C.
U. S. N. M. 30350-1		Locality doubtful
M. C. Z. 6640	type of *orizabensis*	Orizaba, V. C.

The dentition in all is essentially the same.

The tail of two of the four types of *leprosus* is longer than head and body.

U. S. N. M. 6340	♀	112	12	41	59	type of *leprosus*
do	do	85	10	30	45	type of *leprosus*
do	♂	75	9	30	36	type of *leprosus*
do	♀	69	10	31	28	type of *leprosus*

One of the original type series of *leprosus* was separated by Blatchley and made the type of *gibbicaudus*.

U. S. N. M. 19255 ♀ 85 10 39 36 type of *gibbicaudus*

The only difference in proportions I am able to observe in these is that the types of *leprosus* have the appressed toes either meeting or separated by 1 or 2 costal folds. The type of *gibbicaudus* has the appressed toes separated by 4 costal folds. The types of *orizabensis* have the appressed toes separated by 3 costal folds.

Measurements follow:

M. C. Z. 6640		96	11	41	44	type of *orizabensis*
U. S. N. M. 19266	♂	96	12	38	46	type of *orizabensis*

I cannot separate these three forms by examination of the types. *Orizabensis* was described as having a red dorsal stripe. One of the types of *leprosus* had a red dorsal stripe (Cope 1869).

Comparison of a specimen of the series from Guerrero, Hidalgo, with Cope's description of *cephalicus* makes it quite clear that they are the same. If one omits the axillar and inguinal grooves which are

in this species little prominent, one gets a count of 11 costal grooves which was Cope's chief character for *cephalicus*. The series of 17 from Popocateptl shows great variation in color, the females usually having the lighter dorsal stripe. This series makes it quite clear that *orizabensis* is not a distinct species.

Habits: The types of *orizabensis* "were taken from between the bark and wood of a large spruce log, at the height of 11,000 feet on the slope of Mt. Orizaba." The specimens I collected in the pine forest on Popocatepetl, from 8,500-12,000 feet, were much like *Plethodon glutinosus* in their habitat, all coming from the ground, under bark of rotten logs, under chips and débris on the ground. About ten were found in a single log at 11,000 feet.

Remarks: The nearest ally is *rostratus* of the Guatemalan mountains, in which the webbing of the feet is more developed. It is the most primitive member of the series of medium-sized, mountain animals which includes also *rostratus*, *morio*, *subpalmatus*, and *adspersus*.

Specimens seen 52, as follows:

Mexico: Vera Cruz: Orizaba 8 (U. S. N. M. No. 6340, 4 TYPES of *leprosus;* U. S. N. M. No. 19255, TYPE of *gibbicaudus;* U. S. N. M. No. 19266-7 and M. C. Z. No. 6440, TYPES of *orizabensis*); Xometla 1 (M. C. Z. No. 7659); Jalapa 1 (M. C. Z. No. 8376); Queretaro; Piñal de Amoles 1 (U. S. N. M. No. 47204); Hidalgo: Guerrero 20 (U. Mich. No. 48061-2, M. C. Z. No. 3912-29); Distrito Federal: Tlalpam 1 (Mus. Nac. Mexico); Popocatepetl 17 (M. C. Z. No. 8417-32); Michoacan: Patzcuaro 1 (Mus. Nac. Mexico); no locality 2 (U. S. N. M. No. 30350-1).

It has also been recorded from Oaxaca (Brocchi 1883).

OEDIPUS ROSTRATUS (BROCCHI)

1883 *Spelerpes bocourti* (?) Brocchi, Miss. Sci. Mex., p. 111, pl. 18, f. 2 (Tonicapam, Guatemala).

1883 *Spelerpes rostratum* Brocchi, loc. cit., p. 112.

1924 *Oedipus rostratum* Dunn, Zoöl. Ser. Field Mus. Nat. Hist. 12, p. 99.

Type: In Paris Museum.

Type locality: Tonicapam, Guatemala.

Range: High mountains of western Guatemala.

Diagnosis: A medium sized *Oedipus* with toes webbed but two phalanges of third toe free; no groove from eye to gular fold; vomerine series of 14-15 teeth, reaching outer edge of nares; brownish, a lighter dorsal band; belly light.

Description: Field Mus. No. 3487, Sierra Santa Elena, 9,500 ft., near Tecpam, Guatemala; adult male; 13 costal grooves; 3 costal folds between appressed toes; head width 5½ in length from snout to vent; head length 2⅔ in length of body; head a blunt oval; eye as long as its distance from tip of snout; snout swollen, a tubercle below nostril; outline of upper jaw slightly convex as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from hind angle of eye back and down behind angle of jaw; limbs well developed; fingers flat, 3, 4, 2, 1 in order of length, webbed to next to last joint of 3, 1 completely in web; toes flat, 3, 4, 5, 2, 1 in order of length, web to next to last joint of 3, 1 completely in web; tail shorter than body, constricted at base, terete; anal lips lined with papillae; vomerine teeth 14 in series, beginning behind outer edge of nares, curving in and back, separated from its fellow by width of nares and from parasphenoids by ½ their own length; parasphenoids in one narrow patch beginning at middle of eyesocket; three premaxillary teeth pierce the lip; a dark line from eye above insertions of legs to tip of tail; this fades gradually below into the light grayish yellow of the sides and under surface; above it is sharply bordered by a light line from the upper eyelid which fades out on the base of the tail; between these light lines a darker dorsal band with indefinite edges which covers the top of the head and the dorsal surface of the tail; total length 71.5, head 11.5, body 30, tail 30.

Variation: A female, same data, differs in having head length 3¼ in body length; snout less swollen; tail longer than body; anal lips smooth; 15 teeth in vomerine series; no premaxillary fangs; color somewhat lighter, especially on mid-dorsal region; total length 105, head 13, body 42, tail 50.

No very young specimens seen. The smallest, an adult male, is 64 mm. long, head 9.5, body 26.5, tail 28.

Habits: Brocchi's types of *bocourti* and of *rostratus* were taken "on the heights of Tonicapam (western Guatemala). These heights are covered with pine forests, and the *Spelerpes* were found in old trunks of trees." The described specimens were taken from under logs.

Remarks: The specimens I have seen are unquestionably the same as Brocchi's *rostratus*. His *bocourti* is very different in color but the variation in *subpalmatus* and in *cephalicus* is very great; while *morio,*

the closest, has two quite different color phases. It may well be, considering the small series at hand, that I have only specimens of a light phase which Brocchi called *rostratus,* and that he may have called the dark phase *bocourti.* It is very closely allied to *morio,* which has the toes only slightly more webbed.

Specimens seen 5, as follows:

Guatemala: Sierra Santa Elena, near Tecpam, 9,500 ft. 5 (M. C. Z. No. 7370, Field Mus. No. 3487).

It has also been recorded from Tonicapam [Totonicapam], Guatemala (Brocchi 1883).

68. Guatemala, showing localities for Oedipus rostratus.

OEDIPUS MORIO COPE

1868 *Geotriton carbonarius* (black variety) Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 313.

1869 *Oedipus morio* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 103; 1887, Bull. U. S. Nat. Mus. 32, p. 8.

1877 *Geotriton morio* Smith, the Tailed Amphibians, p. 64.

1883 *Spelerpes morio* Brocchi, Miss. Sci. Mex., p. 113; Günther 1902, Biol. Centr. Amer., p. 301.

Type: Apparently no longer in existence. Collected by Dr. Van Patten.

Type locality: Mountains of Guatemala.

Range: Mountains of Guatemala and Honduras.

Diagnosis: A medium sized *Oedipus* with toes webbed so that one phalanx of third toe remains free; vomerine series of about 15 teeth, reaching beyond outer edge of nares; either uniform light reddish brown, or dark gray with light spots or band on dorsal surface.

Description: Field Mus. No. 4546, adult male; mountains west of San Pedro, Honduras, 4,500 ft. altitude; 13 costal grooves, appressed toes overlapping; head width 5 in length from snout to vent; head length 2⅘ in length of body; head truncate, outline as seen from above concave between nostrils; eye as long as its distance from tip of snout; snout strongly swollen; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye down behind angle of jaw; limbs well developed; fingers 3, 4, 2, 1 in order of length, last joint of 3 free of web, tips of 4 and 2 projecting from web, 1 completely in web; toes 3, 4, 5, 2, 1 in order of length, last joint of 3 and 4 free, tips of 2 and 5 free, 1 completely in web; tail longer than body, terete, a basal constriction; vent lined with papillae; vomerine teeth 15-17 in series, beginning beyond outer edge of nares, separated from its fellow by width of nares and from parasphenoids by four times that distance; latter in incompletely divided patches, beginning opposite anterior fourth of eyesocket; six premaxillary teeth piercing lip; light reddish brown, lighter below; a dark line back of eye; costal grooves darker; surface of paws with light dots; total length 111, head 15, body 43, tail 53.

Variation: A female, Field Mus. No. 4560, same data, differs in having 2 costal folds separating the appressed toes; head width 5⅓ in length from snout to vent; head length 3 in length of body; no

papillae in vent; snout not swollen; no enlarged premaxillary teeth; dark gray, lighter below, costal grooves darker; light reddish brown blotches on sides and dorsum; total length 105, head 14, body 42, tail 49.

The collection of 19 specimens from the same locality contains 10 which are like the described male in color, and which may be large or small and of both sexes. Nine are much darker and variously

69. Guatemala and Honduras, showing localities for Oedipus morio.

blotched with lighter. These likewise include different sizes and both sexes. The variations in these nine may be described as follows:

A. Dark, a little light on head and back and base of tail, 4561.
B. Dark, similar but larger light spots, 4554, 4555, 4557.
C. As in the described female, 4558, 4560, 4562.
D. Dark, an immaculate light dorsal band, 4559.
E. Dark, nearly immaculate dorsal band, traces of light dots on paws, 4556.

Thus the variations of the dark forms make an approach to the light phase, and while at first sight the specimens separate easily into two very distinct lots, I am convinced that we have here to do with only one species.

The tail in the smaller specimens is shorter than the body. The vomerine teeth may vary from 12 to 17 in a series, and the series may be separated from the parasphenoids by only twice the width of the naris as in No. 4547.

The appressed toes are separated by two costal folds in two females; by one costal fold in three males, two females, and three young; and meet in seven males and in two young. Thus the body is relatively longer in females, as is generally the case.

Measurements of the series:

Sex	*No.*	*Total*	*Head*	*Body*	*Tail*	*Folds Between Appressed Toes*	*Color*
♂	4546	111	15	43	53	0	light
♂	4551	111	15	43	53	0	light
♂	4559	106	14	42	50	0	dark D
♂	4549	111	15	41	55	0	light
♂	4552	112	15	41	56	0	light
♂	4550	106	15	39	52	0	light
♂	4555	101	14	36	51	0	dark B
♂	4557	94	13	36	45	1	dark B
♂	4553	99	14	36	50	1	light
♂	4561	76	11	30	35	1	dark A
♀	4547	108	14	45	49	2	light
♀	4548	107	14	42	51	1	light
♀	4560	105	14	42	49	2	dark C
♀	4545	98	14	39	45	1	light
yg.	4544	67	11	29	27	0	light
yg.	4558	69	11	28	30	0	dark C
yg.	4556	68	10	27	31	1	dark E
yg.	4554	58	9	27	22	1	dark B
yg.	4562	56	8	25	23	1	dark C

Habits: The specimens were all taken from Bromeliads, some on fallen trees and others from plants growing as high as 40 feet from the ground. No difference was observed in habits or in habitat between dark and light phases.

Remarks: This form is very close to *rostratus* on the one hand and to *subpalmatus* on the other, being both anatomically and geographically intermediate. The dark individuals especially would be very difficult indeed to separate from specimens of *subpalmatus,* which does not, however, have a light phase. The legs of *morio* seem to be longer, as it has 2-0 costal folds between the appressed toes while *subpalmatus* has 2-3.

Specimens seen 19, as follows:

Honduras: Mountains west of San Pedro, 4,500 feet altitude 19 (Field Mus. No. 4544-53).

It has been recorded also from mountains near Guatemala City (Cope 1868) and from Alta Vera Paz, Guatemala (Brocchi 1883).

OEDIPUS SUBPALMATUS (BOULENGER)

1875 *Oedipus morio* Cope, Journ. Acad. Nat. Sci. Philadelphia (2), 8, p. 96; 1879, Proc. Amer. Phil. Soc. 18, p. 271.

1896 *Spelerpes subpalmatus* Boulenger, Ann. Mag. Nat. Hist. (6), 18, p. 341; Günther 1902, Biol. Cent. Amer., p. 300.

1924 *Oedipus subpalmatus* Dunn, Zoöl. Ser. Field Mus. Nat. Hist. 12, p. 99.

Type: In British Museum. Collected by Mr. Underwood.

Type locality: La Palma, Costa Rica.

Range: High mountains of Costa Rica, above 4,000 feet.

Diagnosis: A medium sized *Oedipus* with half-webbed toes; no groove from eye to gular fold; vomerine series 12 teeth, reaching beyond nares; black, usually a light dorsal band; belly dark.

Description: M. C. Z. No. 6953, adult male; Volcano Poas, Costa Rica, 7,000 feet; 13 costal grooves; 2 costal folds between appressed toes; head width 5 in length from tip of snout to vent; head length 3¼ in length of body; head a blunted oval from above; eye a little shorter than its distance from tip of snout; snout swollen; a tubercle below nostrils; cutline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from hind angle of eye back and down behind angle of jaw and across throat; gular fold on sides of neck to dorsal

surface; a groove from gular fold forwards in line with groove from back of eye but the two not meeting; limbs well developed; fingers 3, 2, 4, 1 in order of length, flat, webbed nearly to last joint of 3, 1 completely in web; toes 3, 4, 2, 5, 1 in order of length, flat, webbed nearly to last joint of 3, 1 completely in web; tail longer than head and body, circular in section, constricted off at base; anal lips lined with papillae; vomerine series not continuous with parasphenoids, about 12 teeth in series, beginning outside of nares, curving in and back, separated from its fellow by twice width of nares and by twice that from the parasphenoids which are in one patch beginning at level

70. Costa Rica and Panamá, showing localities for Oedipus subpalmatus.

of anterior quarter of eyesocket; total length 112, head 12, body 39, tail 61; black below and on sides, sprinkled sparsely with white, as in *Plethodon glutinosus* or *Oedipus robustus;* on each side from upper eyelid back above insertions of legs a reddish band, divided on the mid-dorsal line of the body by an indefinite dark area running from the snout to the base of the tail, on the tail the median darker part is quite narrow and in places broken by the red, legs sprinkled above and below with red.

Variation: A female, M. C. Z. No. 6950, same locality, differs in having 3 costal folds between the appressed toes; tail shorter than

head and body; anal lips smooth; much more mottled than male described above; no demarcation between back and sides; throat lighter than belly; sides and back mottled with reddish; a row of white spots along sides above insertion of legs; similar spots on tail; total length 113, head 12.5, body 45.5, tail 55. A young specimen, M. C. Z. No. 6954, same locality, has head width 4½ in length from tip of snout to vent; head length 2⅔ in length of body; and tail shorter than body; a greenish gray band or dorsal surface of head and body; a few scattered spots of same color on tail; sides and beneath black; lighter on throat; a few white flecks on sides and tail; nostril larger in actual diameter than that of the largest specimen; total length 35, head 6, body 16, tail 13.

This species varies a great deal in coloration, and this is not correlated with age or sex. Out of twenty-nine specimens taken on Poas in August, 1920, by myself, one was black all over with a few white flecks about as big as the eye on sides and on tail; three, including the described female, had irregular blotching of lighter on the dorsal surface but no distinct band, and the rest had the light dorsal band as described for the male and the young one. The mid-dorsal dark line as described in the male is not present in the rest save very occasionally and indistinctly.

The largest and smallest specimens seen:

Specimen	*Sex*	*Total*	*Head*	*Body*	*Tail*	*Locality*
M. C. Z. No. 7225	♀	139	13.5	50.5	75	Rancho Redondo
M. C. Z. No. 6954	yg.	35	6	16	13	Poas

Habits: I collected 29 of this species high up on Poas, and of these the great majority were under logs. They were taken in the woods beyond the big "lechería," in the edge of the pasture around the so-called "Hotel de Poas," and in the woods between the hotel and the crater. Eight were found in one log near the hotel. They were quite sluggish and made almost no attempt to escape, although one tried to bite.

Remarks: The relationships of this form are with *morio* to the north and with *adspersus* to the south. It is extremely closely allied to the former and only less close to the latter. The legs are slightly shorter than those of *morio,* the vomerine series is not quite so long, and it does not have the pale phase. The toes are less webbed than those of *adspersus.*

Specimens seen 48, as follows:

Costa Rica: Rancho Redondo 1 (M. C. Z. No. 7225); Turrialba 2 (M. N. C. R., M. C. Z. No. 7219); Barba and Irazu 2 (A. M. N. H. No. 11723-4); Barba, 2,800 m. 1 (U. S. N. M. No. 69452); Cot, near Cartago, 1,600 m. 1 (U. S. N. M. No. 69451); Poas (7,000-8,000 ft.) 36 (M. N. C. Z. No. 6950-78); Tablaze (1,900 m.) 1 (U. S. N. M. No. 37343); Cerro de la Muerte 2 (U. S. N. M. No. 37775-6); no locality 1 (U. S. N. M. No. 29864).

Panamá: Boquete, 3,700 ft. 1 (U. Mich. No. 58500).

It has been recorded from Cartago (Cope 1879), Pico Blanco (Cope 1875), and La Palma (Boulenger 1896).

OEDIPUS ADSPERSUS (PETERS)

1863 *Spelerpes (Oedipus) adspersus* Peters, Mon. Berl. Ak., p. 468.

1865 *Geotriton adspersus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 196.

1869 *Oedipus adspersus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 103; Dunn 1918, Bull. Mus. Comp. Zoöl. 62, p. 471; Noble 1921, Bull. Amer. Mus. Nat. Hist. 44, p. 3, pl. 1, f. 1, pl. 2, f. 2 (skull); Ruthven 1922, Misc. Publ. U. Mich. Mus. Zoöl. 8, p. 49.

1882 *Spelerpes adspersus* Boulenger, Cat. Batr. Grad. Brit. Mus. (2), p. 70; Werner 1900, Verh. Ges. Wien. 50, p. 272; 1916, Zoöl. Anz. 47, 10, p. 302; Leuba 1917, R. Soc. Phys. Hist. Nat. Genève 33, p. 16 (skin and tongue).

1909 *Geotriton andicola* Posada, Estud. cient., p. 125 (Medellin, Colombia).

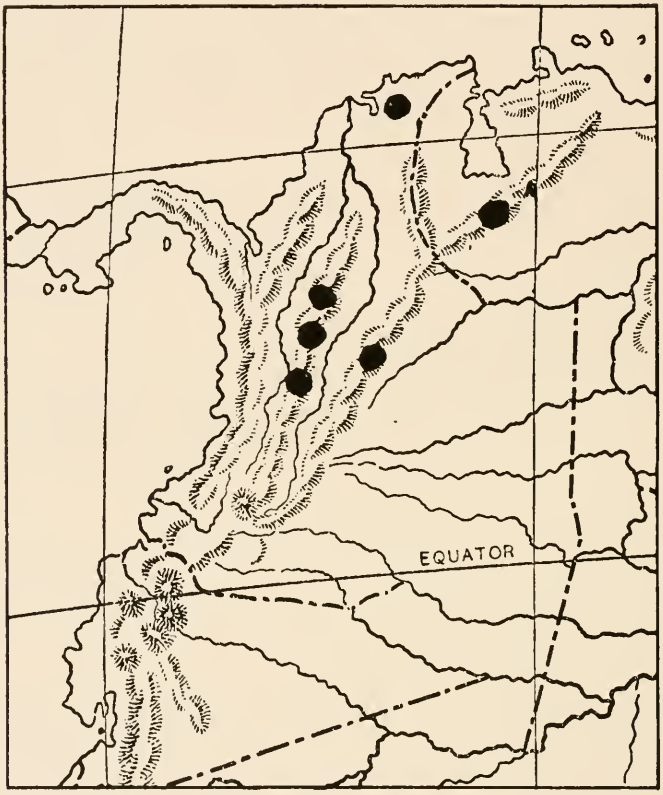
Type: In Berlin Museum(?).

Type locality: Bogota, Columbia.

Diagnosis: A medium sized *Oedipus* with toes nearly entirely webbed, tips free; no groove from eye to gular fold; vomerine series 12 teeth, reaching outer edge of nares; blackish, sometimes with irregular streaks of lighter.

Description: M. C. Z. 3894, adult male; San Lorenzo, Colombia; 13 costal grooves; 4 costal folds between appressed toes; head width 5⅓ in distance from tip of snout to vent; head length 3⅛ in length of body; head a blunted oval from above; eye as long as its distance from tip of snout; snout swollen; tubercle below nostril; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from hind angle of eye back and down behind angle of jaw; gular fold to sides of neck; limbs somewhat weak; fingers 3, 2, 4, 1 in order of length, web beyond last joint of 3 but tip of 3 free, rest entirely in web; toes 3, 4, 2, 5, 1 in order of length, web beyond last joint of 3 but tip of 3 and 4 free, rest entirely in web; tail shorter than head and

body, constricted at base; anal lips lined with papillae; vomerine teeth about twelve in series, beginning behind outer edge of nares, curving in and back, separated from fellow by width of nares and from parasphenoids by twice that distance; latter in single patch beginning op-



71. Colombia and Venezuela, showing localities for Oedipus adspersus.

posite middle of eyesocket; 3 premaxillary teeth pierce lip; maxillary teeth to middle of eyesocket; color a rather uniform blackish brown, tubercles under nostrils and palms of hands and feet white, some light marblings on sides and lower surface of tail; total length 83, head 10, body 32, tail 41.

Variation: A female, M. C. Z. 3895, same locality, has head width 6 in length from snout to vent; the snout is somewhat less swollen, the lips of the anus are smooth; there are no premaxillary fangs; and the white marbling of the under side of the tail is more extensive; total length 99, head 11, body 39, tail 49.

The teeth of the vomerine series may pass beyond the nares. The males are mostly quite close to the described specimen in color, yet A. M. N. H. 13059, from Sta. Rosa de Osa, Colombia, has the dorsal area lighter and streaked with whitish and with a mid-dorsal dark line, and the throat and belly are lighter; another male, A. M. N. H. 13060, from Medellin, Colombia, has the dorsal region lighter and two long white streaks on either side of the mid-ventral line from near the vent to about where the appressed fingers would reach. The females have markings, especially the larger ones. These usually take the form of a lighter dorsal and ventral region, usually there is a mid-dorsal dark line and a mid-ventral dark line, aside from this the light area may be uniform or with fine dark streaks, the mid-dorsal line when present expands on the head and covers the interorbital surface in the shape of a triangle apex backwards. In some specimens there is a trace of an X-shaped marking on the back with the short arms forwards as in *rufescens*. The tail may be longer than the head and body. The nostril in very small specimens is larger in actual diameter than in the largest female.

Largest and smallest specimens:

Specimen	*Sex*	*Total*	*Head*	*Body*	*Tail*	*Locality*
A. M. N. H. No. 13060	♂	110	11.5	38.5	60	Medellin
Field Mus. No. 1915	♀	120	12.	46	62	Sta. Marta
U. Mich. No. 48213	yg.	21	3.5	10.5	7	Sta. Marta

Posada (1909) says it grows to 130 mm.

Habits: Werner (1900) says of some taken at Sibate near Bogota (2,800 m.), "under rotten tree-ferns;" and Posada (1909), "it lives only in the mountains," "in damp places, under stones, shaded by trees or in the cavities of old logs, like the terrestrial salamander of Europe, and, like it, is ovoviviparous." Ruthven (1922) says that in the Santa Marta Mts., "Found principally in bromelias in the trees and on the ground; occasionally found in decaying logs and stumps or under decaying leaves . . . both adults and young were found in the bromelias."

Remarks: Posada's species is unquestionably the same at Peters'. The relationships are with *subpalmatus,* which occurs in western Panamá, and with *altamazonicus* which is widespread on the east face of the Andes as far south as Bolivia. Anatomically it is intermediate between them.

Specimens seen 126, as follows:

Venezuela: Culeta, near Merida 1 (M. C. Z. No. 2605).

Colombia: Santa Marta Mts.: San Lorenzo 2 (M. C. Z. No. 3894-5); Rio Frio 8 (U. S. N. M. No. 36693-700); San Miguel 1 (U. Mich. No. 48195); no locality 16 (Field Mus. No. 1915, U. Mich. No. 45615-20, 45622-6, 45628-30, 48213); Quindio Mts. 1 (M. C. Z. No. 8163); Medellin 2 (A. M. N. H. No. 13060-1); Santa Rosa de Osa 2 (A. M. N. H. No. 13058-9); Bogota 93 (M. C. Z. No. 7220-4, 9083-160, A. M. N. H. No. 10330-9).

It has been recorded also from the following localities near Bogota: Sibate (2,800 m.), Ubaque (3,200 m.), Bogota-Ubaque (2,900 m.), Boqueron (Werner 1900).

OEDIPUS ALTAMAZONICUS COPE

1874 *Oedipus altamazonicus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 120.

1877 *Geotriton altamazonicus* Smith, the Tailed Amphibians, p. 77.

1882 *Spelerpes altamazonicus* Boulenger, Cat. Batr. Grad. Brit. Mus. (2), p. 71; 1898, Proc. Zoöl. Soc. London, p. 479.

1883 *Spelerpes peruvianus* Boulenger, Ann. Mag. Nat. Hist. (5), 12, p. 165, pl. 5 (Moyobamba, Peru).

1897 *Spelerpes palmatus* Werner, Zoöl. Anz. 20, p. 266 (Ecuador).

1911 *Spelerpes simus* Vaillant, Miss. Geogr. Amer. Sud. 9, p. 58 (Ecuador).

Type: Apparently no longer in existence. Collected by Prof. Orton.

Type locality: Nauta, Peru.

Range: Colombia to Bolivia. Eastern foothills of the Andes.

Diagnosis: An *Oedipus* with toes completely webbed; vomerine series short, 7 teeth, beginning behind nares; belly pigmented; rather uniformly dark, or lighter dorsally with irregular streaking; teeth on maxilla; a small species under 100 mm. long.

Description: M. C. Z. No. 5124, Rio Pacaya (Ucayali), Peru, 200 feet, adult female; costal grooves 12; 5 costal folds between appressed toes; head width 6⅓ in length from tip of snout to vent; head length 3⅓ in length of body; head a blunted oval from above; eye about as long as its distance from tip of snout; snout not swollen; tubercle under nostril; outline of upper jaw straight as viewed from side; angle of jaw slightly behind hind angle of eye; both eyelids fitting under a

fold of skin behind; grooves of head not evident; gular fold to sides of neck; limbs weak; finger and toes flat, completely webbed, tip of third finger and toe projecting slightly; tail longer than head and body, a constriction at base, circular in cross section; anal lips smooth; vomerine series not continuous with parasphenoids, about 7 teeth in series beginning behind outer edge of nares, extending straight in and back, separated from its fellow by width of nares, and from parasphenoids by its own length; latter in a single patch, beginning about middle of eyesocket; maxillary teeth to anterior edge of eyesocket; uniform grayish black, slightly lighter below; total length 85, head 9, body 31, tail 45.

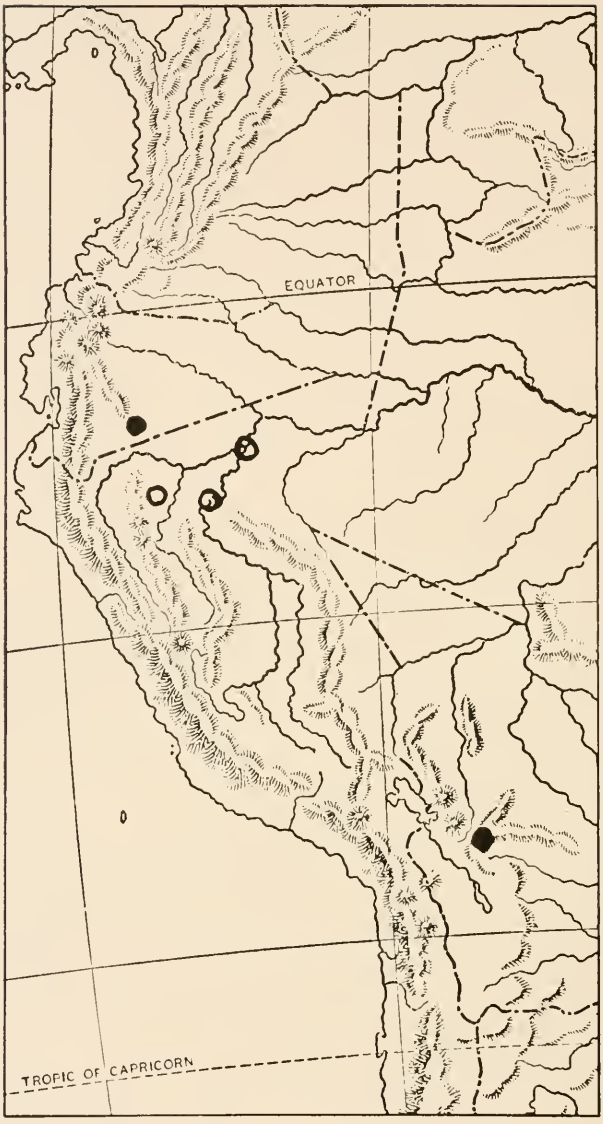
Variation: U. S. N. M. No. 20591, adult female, Rio Santiago, Ecuador, differs in having 13 costal grooves; 3 costal folds between appressed toes; head length 3 in length of body; vomerine teeth beginning behind inner edge of nares, 7-9 teeth in series, separated from its fellow by ½ width of nares; dark on sides, lighter above and below; a dark blotch on head; mid-dorsal region light with irregular darker blotches which tend to assume the appearance of two stripes; total length 85, head 12, body 36, tail 37.

A. M. N. H. No. 3746, adult female, Cochabamba, Bolivia, has 13 costal grooves; 3 costal folds between appressed toes; head width 5½ in length from snout to vent; head length 3 in length of body; a groove from eye down behind angle of jaw; blackish brown; ventral surface with scattered white specks; dorsal region lighter, somewhat streaked; total length 42, head 11, body 31, tail missing.

U. S. N. M. No. 22453, adult female, "Ecuador or Colombia," poor condition; costal grooves?; 3-4 costal folds between appressed toes; head width 6½ in length from snout to vent; head length 3 5/9 in length of body; vomerine teeth 6 in series, beginning behind inner edge of nares, separated from its fellow by width of nares and from parasphenoids by twice that distance; brownish, much faded; total length 41, head 9, body 32, tail missing.

Measurements of specimens from literature:

	Total Length	*Head*	*Body*	*Tail*	*Costal Grooves*
Simus	95	12	29	54	9
Peruvianus	75	9	30	36	12
Altamazonicus	82	7	33	42	13



72. Colombia to Bolivia, showing localities for Oedipus altamazonicus.

	Total Length	*Tail*
Palmatus	37.5	16
Palmatus	70	35
Palmatus	80	40

The dentition of *peruvianus* is described as like that of the Rio Pacaya specimen; that of *altamazonicus* and *palmatus* as like that of the Rio Santiago, and the "Ecuador or Colombia" specimens.

Remarks: M. C. Z. No. 5124 was sent by Boulenger as *peruvianus* but it only agrees with the description of the vomerine dentition and in other points it agrees with the description of *altamazonicus*. There is no real difference mentioned in the descriptions to distinguish between *altamazonicus* and *palmatus*. Vaillant's description of *simus* is very poor, his count of 9 costal grooves is impossible for an animal of the family, and his observations of the vomerine dentition were confined to feeling for them with a pin. His figure shows an animal like the Rio Pacaya specimen.

The four specimens I have seen indicate not more than a single species, a conclusion to which Boulenger apparently came in an article in the latest Encyclopedia Britannica. If this conclusion be correct, it affords an amusing example of nationalism in science whereby the same animal bears four names, given it by an American, an Englishman, an Austrian, and a Frenchman.

The only definite localities are on the east face of the Andes. The animal is closely related to *adspersus* of the higher altitudes in Colombia. There may be also a certain affinity with *colonneus* of western Panamá, but more material of both these forms is badly needed.

Specimens seen 4, as follows:

Ecuador: Rio Santiago 1 (U. S. N. M. No. 20591).
Peru: Rio Pacaya 1 (M. C. Z. No. 5124).
Bolivia: Cochabamba 1 (A. M. N. H. No. 3746).
Ecuador or Colombia: 1 (U. S. N. M. No. 22453).

It has also been recorded from "Ecuador" (*palmatus* Werner 1897, *simus* Vaillant 1911), "Colombia" (*altamazonicus* Boulenger 1898), Nauta, Peru (*altamazonicus* Cope 1874), Moyabamba, Peru (*peruvianus* Boulenger 1883).

OEDIPUS PLATYDACTYLUS (CUVIER)

1831 *Salamandra variegata* Gray, in Griffith's Cuvier's Animal Kingdom 9, p. 107 (not of Bory, St. Vincent 1829, Dict. Class. Hist. Nat. 15, p. 68), (Mexico, types in Brit. Mus.).

1850 *Oedipus variegatus* Gray, Cat. Batr. Grad. Brit. Mus., p. 48; 1858, Ann. Mag. Nat. Hist. 2, p. 300; Moore 1900, Proc. Acad. Nat. Sci. Philadelphia, p. 619 (vertebrae); Fowler and Dunn 1917, Proc. Acad. Nat. Sci. Philadelphia, p. 19.

1870 *Spelerpes variegatus* Strauch, Mém. Acad. Sci. St. Petersbourg (7), 16, 4, p. 84; Mueller 1878, Verh. Ges. Basel 6, p. 579; Boulenger 1882, Cat. Batr Grad. Brit. Mus. (2), p. 73; Lönnberg 1899, Zoöl. Anz., p. 545 (lunglessness); Günther 1902, Biol. Centr. Amer., p. 302, pl. 75, ff. A, B, C; Werner 1903, Abh. Bayer. Ak. 22, p. 352; Gadow 1905, Proc. Zoöl. Soc. London, p. 203; 1910, Zoö.l Jahrb., p. 305; Ruthven 1912, Zoöl. Jahrb. 23, p. 305; 1912, Report Michigan Acad. Sci. 14, p. 231.

1884 *Geotriton variegata* Garman, Bull. Essex Inst. 16, p. 39.

1831 *Salamandra platydactylus* Cuvier in Gray, l. c., p. 107 (in synonymy of *variegata*).

1838 *Oedipus platydactylus* Tschudi, Mém. Soc. Sci. Nat. Neuchâtel, p. 58.

1854 *Bolitoglossa mexicana* Duméril and Bibron, Erp. Gén. 9, p. 93, pl. 104, f. 1 (Dolores, Peten, Guatemala).

1883 *Spelerpes mexicanum* Brocchi, Miss. Sci. Mex., p. 113, pl. 18b, ff. 1, 2, 3, 4.

1884 *Geotriton mexicana* Garman, Bull. Essex Inst. 16, p. 40.

1894 *Spelerpes mexicanus* Dugés, La Naturaleza (2), 2, p. 377.

1860 *Geotriton carbonarius* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 373 (no locality, types in A. N. S. from Jalapa, Mexico); 1866, Journ. Acad. Nat. Sci. Philadelphia (2), 6, p. 98.

1869 *Oedipus carbonarius* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 103; 1879, Proc. Amer. Phil. Soc. 18, p. 267; Sumichrast 1881, Bull. Soc. Zoöl. France, p. 231; 1882, La Naturaleza 6, 3, p. 78.

1883 *Spelerpes punctatum* Brocchi, Miss. Sci. Mex., p. 115 (Mexico).

1883 *Spelerpes mulleri* Brocchi, l. c., p. 118, pl. 20, ff. 3, 4, 5 (Alta Vera Paz, Guatemala).

1883 *Spelerpes Copei* Brocchi, l. c., p. 113 (nomen nudum, synonym of *mulleri* Brocchi).

Type: Apparently no longer in existence.

Type locality: Mexico.

Range: Southern Mexico, northern Guatemala, British Honduras, Honduras.

Diagnosis: An *Oedipus* with completely webbed toes; 13 costal grooves; 3-4 costal folds between appressed toes; long vomerine series (14 teeth); belly dark, a light clear dorsal band, with irregular darker markings; vomerine and parasphenoid series close together.

Description: U. S. N. M. 6338, adult male; Orizaba, Vera Cruz,

Mexico; 13 costal grooves; 3 costal folds between appressed toes; head width 6½ in distance from snout to vent; head length 3⅗ in length of body; head oval from above; eye shorter than its distance from tip of snout; snout swollen; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; hind part of both eyelids fitting under a fold of skin; a groove from eye back and down behind hind angle of jaw; gular fold to sides of neck; limbs well developed; fingers flattened, completely webbed; toes flat, completely webbed; tail missing, constricted off at base; anal lips lined with papillae; vomerine teeth 14 in series, beginning behind outer edge of nares, curving slightly in and back, separated from its fellow by

73. Mexico to Honduras, showing localities for Oedipus platydactylus.

½ the width of the nares, and from parasphenoids by a little over the width of the nares; latter in a single patch, beginning opposite anterior fourth of eyesocket; two premaxillary teeth pierce lip; chocolate brown, darker on dorsal surface, lighter below; on dorsal region from between eyes a yellow band with variegations of the ground color; these take the form of a triangular blotch on neck and occiput, base between eyes, and an irregular much broken streak near the outer edge of the yellow band on each side; total length 68, head 14.5, body 52, tail 1.5.

Variation: A female, Mus. Comp. Zoöl. No. 2314, "Mexico," differs in having 4 costal grooves between the appressed toes; head width 7½ in distance from snout to vent; head length about 4 in length of body; snout less swollen; tail longer than head and body; anal lips smooth; no enlarged premaxillary teeth; color similar to that of described male but the yellow dorsal band which extends to the tip of the tail is much less broken by blotches of ground color; the triangular blotch between the eyes is present, the apex running to the insertions of the arms; there is a series of small, widely separated dots in the position of the broken streak of the male, on each side near the outer edge of the dorsal band; a few spots of ground color on the dorsum of the tail; total length 144.5, head 13.5, body 55, tail 76.

The Mexican specimens seen are all much alike, the described male being much darker than the average. Some lack any markings on the dorsal band except the interocular triangle. The specimens seen from British Honduras, Honduras, and Guatemala, are all darker. The specimens figured in literature bear out this general statement, but the classification of the southern animals presents difficulties. I have here to acknowledge the help of Miss Joan Procter, who made careful notes for me of the specimens in the British Museum.

The Mexican form, to which the types of *variegatus* and *carbonarius* belong is the one described above. This may be occasionally much darker, as in the figures of Günther (1902), pl. 75, f. C, and B. Figure B from the Pacific coast of Guatemala has only a few traces of the dorsal band in the form of "a paired lateral series of greatly elongated coffee-coloured spots to about the fourth costal segment; 7 roundish, irregularly scattered spots on posterior half of back, and root of tail."

South of Mexico, on the Atlantic slope, the animals are similar but with much dark on the dorsal band. This is well represented by the figure of a specimen from Dolores, Peten, Guatemala, in Duméril and Bibron (1854) considered as a variety of their *Bolitoglossa mexicana.* Exactly similar specimens have been seen from Middlesex and from Benque Viejo, British Honduras.

Another form is that called *Spelerpes mulleri,* by Brocchi (1883), pl. 20, ff. 3, 4, 5. The types came from Alta Vera Paz, Guatemala. Two specimens of this dark phase have been seen from Manitee River, British Honduras. Field Mus. No. 3238 is dark chocolate brown

above, lighter below; 3 narrow, broken, wavy yellow streaks; a mid-dorsal one beginning on neck, two dorsolateral ones beginning on head; occasional cross lines join these streaks. Field Mus. No. 3237 is dark brownish black above, slightly lighter below; a trace of the dorsolateral lines can be seen on the head, above and behind the eyes. Werner (1903) records a similar specimen from Guatemala.

Günther (1902) figures a specimen from British Honduras on plate 75, f. A. This has three rather well developed light dorsal lines, or rather the dark pigment on the light dorsal area takes the form of two series of elongate blotches. Six specimens exactly like this figure have been seen from Lake Yojoa, and Tela, Honduras.

The ranges of the last two phases are not separate. The darkest forms are apparently on the Pacific coast of Guatemala and in Alta Vera Paz and on the Manitee River in British Honduras, and on the Atlantic slope they interpose themselves between the lighter form from Dolores, Middlesex and Benque Viejo, and the lighter form from Lake Yojoa, which last also is found in British Honduras. At present I cannot see my way clear to recognize any of these as distinct from the Mexican light form. I can detect no differences save those of color, and these differences are neither so distinctive nor so arranged geographically as to seem particularly significant.

The dentition is fairly constant, 9-14 teeth in the vomerine series, separated from its fellow by ½-1 times the width of the nares, and separated from the parasphenoids by 2-3 times the width of the nares. The head length is contained from 3-4 times in the length of the body, and the head width from 5½ to 8 times in the length from snout to vent. In the smallest specimens the tail is shorter than the body, and the nostril is relatively larger than in the adult. I give the measurements of the largest and smallest of the typical phase, and of all that I have seen from south of Mexico.

Specimen	Sex	Total Length	Head	Body	Tail	Locality	Color
U. S. N. M. 12483	♀	189	19.5	79.5	90	No locality	typical
U. S. N. M. 6338	♂	68	14.5	52	1.5	Orizaba	typical
U. S. N. M. 6878		45	5.5	22	17.5	No locality	typical
U. S. N. M. 65131	♂	123	13	37	63	Benque Viejo	"mexicana"
Field Mus. 4268	♀	125	14	51	60	Middlesex	"mexicana"
Field Mus. 4269	♂	110	13	42	55	Middlesex	"mexicana"
Field Mus. 4270	♀	154	15	59	80	Middlesex	"mexicana"
Field Mus. 3237	♀	119.5	13.5	45	61	Manitee R.	"mulleri"
Field Mus. 3238	♂	49	12	37	0	Manitee R.	"mulleri"
Field Mus. 4539	♀	106	12	43	51	Lake Yojoa	"Günther, f. A"
Field Mus. 4540	♂	96	12	41	43	Lake Yojoa	"Günther, f. A"
Field Mus. 4541	♀	111	12	45	54	Lake Yojoa	"Günther, f. A"
Field Mus. 4542	♂	111	13	45	53	Lake Yojoa	"Günther, f. A"
Field Mus. 4543	♂	101	12	38	51	Lake Yojoa	"Günther, f. A"

Habits: Ruthven (1912a) says of a specimen taken at Cuatotolapam, Vera Cruz, "Found among the leaves in the woods along La Laja Creek. It had in its mouth the remains of a ground beetle." The specimens I collected at Jalapa were under stones in rather open fields. Cope (1879) says that specimens sent him by Sumichrast from Tehuantepec were found in tufts of Tillandsia. Sumichrast himself (1881) says of *O. rufescens* that it is found in such places near Santa Efigenia, and of *"carbonarius";* "same," "but up to 2,500 m. on the Gulf of Mexico." In 1882 he said that it was "alpine" and under stones and rotten logs," in Chiapas. Gadow (1905) says it reaches 9,000 feet on Orizaba. The Middlesex specimens were taken on the ground. The Lake Yojoa specimens, from an elevation of 2,000 feet, were taken in Bromeliads.

Remarks: The records and specimens from Tehuantepec are open to doubt. All specimens sent in by Sumichrast were liable to be considered as from that place, but he nowhere says that *platydactylus* occurs on the Pacific coast. Modern specimens will doubtless eventually clear up this problem and also the question concerning the dark forms from the Pacific and Atlantic slopes south of Mexico.

The relationships of *platydactylus* are with *salvinii* and with *lignicolor,* rather than with the more aberrant *attitlanensis* or *yucatanus.* Of these *salvinii* is closest, both structurally and geographically and the question of their relations at their place of meeting is yet to be answered. From present records and specimens it would seem that

both occurred together and remained distinct. But as far as one can judge from reading the remarks of Sumichrast, who did most of the collecting, they do not occur together, and *salvinii* is on the Pacific coast and *platydactylus* on the Atlantic. This seems to me more probable. The non-pigmented belly of *salvinii* distinguishes it at once.

Specimens seen 42, as follows:

Mexico: Oaxaca: Tehuantepec 3 (U. S. Nat. Mus. No. 30344-6): Barrias 1 (U. S. Nat. Mus. No. 30528); Vera Cruz: Jalapa 6 (A. N. S. No. 503-4, types of *carbonarius;* Mus. Comp. Zoöl. No. 8377-80); Orizaba 5 (U. S. Nat. Mus. No. 6338); Motzorongo 2 (Mus. Nac. Mexico); Achotal 1 (Field Mus. 1485); Cuatotolapam 1 (U. Mich. 41573); Tabasco: Macuspam 1 (Mus. Nac. Mexico); no locality 10 (U. S. Nat. Mus. No. 6892 (2), 6878 (4), 12242, 12483; Mus. Comp. Zoöl. No. 2314, A. N. S. (1)).

British Honduras: Benque Viejo 1 (U. S. Nat. Mus. No. 65131); Middlesex 3 (Field Mus. No. 4269-70); Manitee R. 2 (Field Mus. No. 3237-8).

Honduras: Lake Yojoa 5 (Field Mus. No. 4539-43); Tela 1 (M. C. Z. No. 10214).

It has been recorded from the following places: Guichicovi, Oaxaca; Chiapas (Sumichrast 1882); Huatusco, Vera Cruz (Sumichrast 1882); Presidio, Tetela, and San Juan Evangelista, Vera Cruz (Gadow 1905); Dolores, Peten, Guatemala (Duméril and Bibron 1854); Alta Vera Paz, Guatemala (Brocchi 1883). The record for Mexico City (Boulenger 1882), and that for Cuba (Mueller 1878) are in all probability erroneous.

OEDIPUS SALVINII GRAY

1868 *Oedipus salvinii* Gray, Ann. Mag. Nat. Hist. (4), 2, p. 297; Sumichrast 1880, Bull. Soc. Zoöl. France 5, p. 190; 1882, La Naturaleza 6, p. 79.

1879 *Oedipus carbonarius salvinii* Cope, Proc. Amer. Phil. Soc. 18, p. 267.

1887 *Oedipus variegatus salvinii* Cope, Bull. U. S. Nat. Mus. 32, p. 8.

1878 *Spelerpes salvinii* Mueller, Verh. Ges. Basel 6, p. 579; Brocchi 1883, Miss. Sci. Mex., p. 117, pl. 18, ff. 3, 4.

1896 *Spelerpes variegatus* Werner, Verh. Ges. Wien. 46, p. 351; Günther 1902, Biol. Cent. Amer., pl. 75, f. D.

Type: Brit. Mus. No. 65.10.19, collected by Osbert Salvin.

Type locality: Guatemala, Pacific Coast.

Range: West Coast of Central America from Mexico to Costa Rica.

Diagnosis: An *Oedipus* with fully webbed toes, unpigmented belly, vomerine teeth about 10 in series, light areas on dorsal surface outlined with lighter.

Description: American Museum 2606, adult female; Tonala, Chiapas, Mexico; costal grooves 13; 4 costal folds between appressed toes; head width 6 in distance from snout to vent; head length 3 5/13 in length of body; head a blunt oval from above; eye as long as its distance from tip of snout; snout somewhat swollen; tubercle under nostril; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; hind part of both eyelids fitting under a fold of skin; a groove from eye down and back behind angle of jaw; gular fold to sides of neck; limbs well developed, fingers and toes very flat, completely in web; tail constricted at base, shorter than head and body; anal lips smooth; vomerine teeth about 9 in series, beginning behind inner edge of nares, running almost straight in and back, separated by width of nares and from parasphenoids by twice that distance; latter in a single patch beginning opposite anterior quarter of eyesocket; no teeth on maxilla posterior to level of nares; color, orange yellow, a dark line from eye to base of tail just above insertions of limbs, narrowly bordered with white above; an irregular white edged dark streak from between eye to a little past axillar region, followed by one irregular blotch and then a paired series of smaller somewhat elongated blotches to base of tail, all similar in color; some similar blotches on dorsal part of tail; a blotch on forearm and on lower leg; immaculate beneath; total length 108, head 13, body 44, tail 51.

Variation: Another female, U. S. N. M. 30305, Tehuantepec, Mexico, has head width 7 in length from snout to vent; head length 3 11/18 in length of body; tail as long as head and body; vomerine teeth beginning behind outside edge of choanae; teeth on maxilla to level of middle of eyesocket; color similar, but lateral black stripes broader and dorsal markings not divided into a paired series; interocular blotch reaching middle of body; black on both upper and lower arms and legs; total length 166, head 18, body 65, tail 83.

U. S. N. M. 37772, adult male, Miravalles, Costa Rica; costal grooves 13; 4 costal folds between appressed toes; head width 7 in length from snout to vent; head length 4 in length of body; head oval from above; eye as long as its distance from tip of snout; snout slightly swollen; outline of upper jaw straight as seen from side; angle of jaw slightly back of hind angle of eye; hind part of both eyelids fitting under a fold of skin; a groove from eye down and back behind angle

of jaw; gular fold to sides of neck; limbs well developed; fingers and toes very flat, completely in web; tail constricted off at base, circular in cross section, a little shorter than head and body; anal lips lined with papillae; vomerine teeth about 10 in series, beginning back of outer edge of nares, running in and back, separated by ½ the width of the nares, and from parasphenoids by twice the width of the nares; latter in a single patch, beginning opposite first third of eyesocket; 3 enlarged premaxillary teeth pierce lip; maxillary teeth to middle of

74. Mexico to Costa Rica, showing localities for Oedipus salvinii.

eyesocket; color much bleached in alcohol; apparently originally dark brown, light below; on dorsal region, a mid-dorsal and two lateral light streaks separated by two dorsolateral streaks of ground color, all of the same width and with wavy outlines; the dark streaks are broken across in one or two places; tail with a light dorsal stripe much spotted with ground color; total length 117, head 12, body 48, tail 57.

Habits: Sumichrast (1880) says, "The only *urodele* found in the western plains of the Isthmus [Tehuantepec]." "Damp places in banana plantations, under bark of dead trees."

Remarks: Sumichrast's words quoted above indicate that *salvinii* and *platydactylus* do not occur together in Mexico. It is possible that they, together with the local mountain *attitlanensis,* are merely specially distinct forms of a wide ranging species. The specimens of *platydactylus* at my disposal are not sufficient to indicate more than a local constancy in type of coloration. The more southern specimens of *platydactylus,* especially some from Lake Yojoa, in Honduras, are those that approach *salvinii* most closely. It is therefore likely that the two are now or were originally connected in the south and split around the Cordillera. At present typical specimens are quite distinct. For instance *platydactylus* lacks the prefrontal bone and *salvinii* has it well developed.

Specimens seen 3, as follows:

Mexico: Tonala, Chiapas 1 (A. M. N. H. No. 2606); Tehuantepec, Oaxaca 1 (U. S. N. M. No. 30305).
Costa Rica: Miravalles 1 (U. S. N. M. No. 37771).

It has also been recorded from the west coast of Guatemala (Gray 1868); Honduras (Werner 1896); Costa Grande, Retaluleu, Guatemala (Mueller 1878); and it is probably this form that has been recorded from San Carlos, Costa Rica (Günther 1902).

OEDIPUS ATTITLANENSIS (BROCCHI)

1878 *Spelerpes* sp. Mueller, Verh. Ges. Basel 6, p. 645, pl. 3, ff. c, c', d.
1883 *Spelerpes attitlanensis* Brocchi, Miss. Sci. Mex., p. 118, pl. 19, ff. 3, 4.
1924 *Oedipus attitlanensis* Dunn, Zoöl. Ser. Field 12, p. 99.
1884 *Spelerpes atitlanensis* Mueller, id. 7, p. 298.
1896 ? *Spelerpes mulleri* Dugés, La Naturaleza (2), 2, p. 482.

Type: In Paris Museum. Collected by Bocourt.

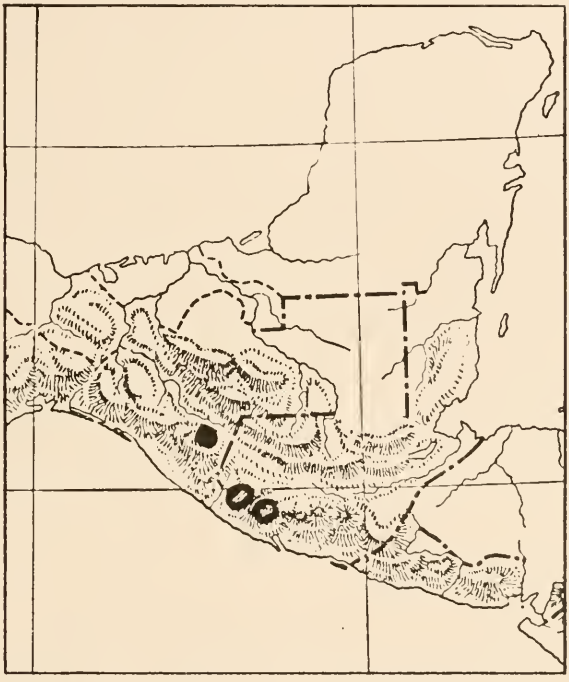
Type locality: Volcan de Attitlan, Guatemala.

Range: Mountains of Guatemala and southern Mexico.

Diagnosis: An *Oedipus* with fully webbed toes, light belly, long vomerine series, and light lines on dark dorsal surface not outlined with lighter.

Description: U. S. N. M. No. 46922, adult female; Chicharras, Chiapas, Mexico; 13 costal grooves; 4 costal folds between appressed toes; head width 6¾ in length from snout to vent; head length 3¾ in length of body; head a pointed oval; eye longer than its distance from tip of snout; snout not swollen; outline of upper jaw as seen from side

straight to below hind angle of eye then convexly downwards to angle; angle of jaw well back of hind angle of eye; hind part of both eyelids fitting under a fold of skin; a groove from hind angle of eye back and down past angle of jaw; gular fold to sides of neck; limbs well developed; fingers and toes very flat, completely enclosed in web; tail terete, constricted off at base, a little shorter than head and



75. Mexico and Guatemala, showing localities for Oedipus attitlanensis.

body; anal lips smooth; vomerine teeth about 17 in series, beginning outside outer edge of nares, curving in and back, separated from its fellow by width of nares, and from parasphenoids by twice that distance; latter in a single patch beginning opposite anterior third of eyesocket; teeth on maxilla to middle of eyesocket; color light yellow, from eye to base of tail a broad chocolate brown band with a fairly even lower edge at level of insertion of legs; this invades the ventral

surface slightly in region of gular fold and over the coracoids; legs blotched with brown; upper limit of lateral band very uneven due to a narrow irregular band of ground color separating lateral dark band from a mid-dorsal band of the same color which begins between the eyes and stretches unbroken to base of tail; a single dark spot on tip of snout; tail clouded with darker below, on sides and above with irregular spots of chocolate brown separated by narrow lines of yellow ground color; immaculate beneath; total length 188, head 20, body 75, tail 93.

Variation: A young specimen, U. S. N. M. 46923, same data, varies in proportions and coloration; tail same length as body; head length 3⅕ in length of body; head width 5½ in length from snout to vent; teeth in maxilla to level of nares; colors same as adult but the dark is much less in amount; a narrow dark line from eye to base of tail above insertions of legs, more or less interrupted, a line of dark blotches in mid-dorsal region from between eyes to base of tail, the largest running from eye to just past insertion of arm and twice as broad as lateral stripe, 3 or 4 dark spots on sides of tail, a dark spot on each thigh; total length 74, head 10, body 32, tail 32.

Habits: According to the Field Notes of Nelson and Goldman the two specimens were taken at "2,800 feet. Earth on wooded hillside."

Remarks: The common character of a light belly allies this species to *salvinii,* from which it differs in having a different dorsal coloration, and a longer series of vomerine teeth.

Specimens seen 2, as follows:

Mexico: Chiapas: Chicharras, 2,800 ft. 2 (U. S. N. M. No. 46922-3).

It has been recorded from the Volcan de Attitlan, Guatemala (Brocchi 1883); Costa Grande, Retaluleu, Guatemala (Mueller 1878); and it is probably this form that Dugés has recorded from Chiapas as *mulleri* (1896).

OEDIPUS LIGNICOLOR (PETERS)

1873 *Spelerpes (Oedipus) lignicolor* Peters, Mon. Berlin Ac., p. 617; 1882, S. B. Ges. Nat. Fr. Berlin, p. 137.
1893 ? *Oedipus variegatus* Cope, Proc. Amer. Phil. Soc. 31, p. 335.
1902 *Spelerpes lignicolor* Günther, Biol. Cent. Amer., p. 302.
1924 *Oedipus lignicolor* Dunn, Zoöl. Ser. Field Mus. Nat. Hist. 12, p. 99.

Type: In Berlin Museum. Collected by H. Ribbe.

Type locality: Chiriqui, Panama.

Range: Western Panama to Costa Rica.

Diagnosis: An *Oedipus* with fully webbed toes; belly dark with light linear markings; dorsal surface light, much washed with darker; teeth on maxilla.

Description: A. M. N. H. 11725, adult female; Sarapiqui, Costa Rica; 13 costal grooves; 3 costal folds between appressed toes; head width 6 in length from tip of snout to vent; head length 4 in length of body; head a blunt oval from above; edge of upper jaw straight as seen from side; eye shorter than its distance from tip of snout; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from hind angle of eye curving back and down past angle of jaw; limbs well developed; fingers entirely in web, third longest; toes entirely in web, third and fourth apparently equal in length, fifth much broader than the others; anal lips smooth; tail circular in cross section, constricted off at base, shorter than head and body; vomerine teeth about 11 in irregular patch-like series beginning behind outer edge of nares, passing nearly straight in and a little back, separated from fellow by twice width of nares, and from parasphenoids by the same distance; latter in a single patch beginning at anterior third of eyesocket; maxillary teeth to anterior edge of eyesocket; black; upper surface, sides of head and tail nearly covered with a yellow lichen-like color; beneath, on sides of body, and on legs dark with small linear whitish markings; total length 170, head 17, body 70, tail 83.

Variation: U. Mich. No. 58497, adult male, Progreso, Chiriqui, Panamá, 90 ft., differs in having head width 5½ in length from snout to vent; head length 3 in length of body; vent papillate; snout swollen; vomerine teeth 11 in series, beginning behind middle of nares, running in and back, separated from its fellow by width of nares, and from parasphenoids by twice that distance; latter in a single patch, beginning at anterior third of eyesocket; dark gray, slightly lighter below; upper surface reddish gray with irregular streaks of the darker ground color; a dark stripe on neck which forks forward to eyelids, a darker patch on interorbital space and on snout; limbs black with light linear markings; under surface with light dots and dashes; total length 107, head 13, body 41, tail 53.

The tail may be shorter than the body in the young or longer than

head and body in the adult. In a female from Boquete, Chiriqui, Panamá, U. Mich. No. 58495, the head width is 6⅓ in the length from snout to vent; the vomerine teeth number 14; the series are separated from the parasphenoids by the width of the nares, four costal folds separate the appressed toes.

Measurements of specimens:

Specimen	*Sex*	*Total Length*	*Head*	*Body*	*Tail*	*Locality*
A. M. N. H. No. 11725	♀	170	17	70	83	Sarapiqui, C. R.
U. Mich. No. 58495	♀	150	18	64	68	Boquete
U. Mich. No. 58490	♀	121	16	55	50	Boquete
U. Mich. No. 58489	♂	120	15	49	56	Boquete
U. Mich. No. 58498	♀	130	14	49	67	Progreso
U. Mich. No. 58494	♀	90	15	48	27	Boquete (tail reproducing)
U. Mich. No. 58497	♂	107	13	41	53	Progreso
U. Mich. No. 58493	yg.	90	11	32	41	Boquete
U. Mich. No. 58491	yg.	83	11	33	39	Boquete
U. Mich. No. 58492	yg.	68	9	32	27	Boquete
U. Mich. No. 58496	yg.	53	8	24	21	Progreso
A. M. N. H. No. 21375	yg.	33	3.5	15	14.5	Rio Tapia

76. Panamá and Costa Rica, showing localities for Oedipus lignicolor.

Habits: The specimens which have data were caught as follows: The described male was caught on wild pineapple leaves at night; the large female from Progreso was taken from a rotten log; the Boquete specimens were taken one from a Bromeliad and the rest from Calladiums.

Remarks: Allied to but more primitive than *yucatanus,* this form is rather a link between it and *platydactylus.* The geographical situation does not seem to bear this out, but so little is really known of the rain-forest forms between Panamá and Yucatan that perhaps a series of species may yet be found to connect the two, a series which will perhaps parallel the *platydactylus-salvinii* series.

Specimens seen 12, as follows:

Costa Rica: Sarapiqui 1 (A. M. N. H. No. 11725).

Panamá: Chiriqui: Progreso, 90 ft. 3 (U. Mich. No. 58496-8); Boquete, 3,800 ft. 7 (U. Mich. No. 58489-95); Panamá: Rio Tapia, 20 miles east of Ancon, C. Z. 1 (A. M. N. H. No. 21375).

Probably this is the form recorded by Cope (1893) from Buenos Ayres, Costa Rica.

OEDIPUS YUCATANUS (PETERS)

1868 *Geotriton carbonarius* (part) Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 313.

1882 (Nov. 21) *Spelerpes (Oedipus) yucatanus* Peters, S. B. Ges. Nat. Fr. Berlin, p. 137.

1883 *Spelerpes yucatanus* Boulenger, Zoöl. Rec., p. 72; Günther 1902, Biol. Centr. Amer., p. 303; Barbour and Cole 1906, Bull. Mus. Comp. Zoöl. 50, p. 155.

1924 *Oedipus yucatanus* Dunn, Zoöl. Ser. Field Mus. Nat. Hist. 12, p. 99.

1882 (Nov. 26) *Spelerpes yucatanicus* Boulenger, Cat. Batr. Grad. Brit. Mus. (2), p. 72 (Yucatan, Mexico, type in British Museum).

1918 *Oedipus yucatanicus* Dunn, Bull. Mus. Comp. Zoöl. 62, p. 471.

1883 *Oedipus jucatanicus* Cope, Bull. U. S. Nat. Mus. 32, p. 8.

1883 *Spelerpes* sp. Brocchi, Miss. Sci. Mex., p. 116.

1903 *Spelerpes doffleini* Werner, Abh. Bayer Ak. 22, p. 352 (Guatemala).

Type: Mus. Berlin No. 10231, purchased from Boucard in Paris.

Type locality: Yucatan, Mexico.

Range: Yucatan, Mexico, and Peten, Guatemala.

Diagnosis: An *Oedipus* with fully webbed toes; vomerine series an irregular patch of teeth reaching outer edge of nares; belly dark, sometimes with small light linear markings; upper surface with irregular mottlings of lighter, more or less concentrated in two dorsolateral lines.

Description: M. C. Z. No. 2773, adult female; Chichen Itza, Yucatan, Mexico; 13 costal grooves; 5 costal folds between appressed toes; head width 6½ in length from tip of snout to vent; head length 4 in length of body; head very blunt in outline from above; eye shorter than its distance from tip of snout; snout swollen, quite high; a slight swelling below nostril; outline of upper jaw straight as viewed from side; angle of jaw well back of hind angle of eye; hind part of both eyelids fitting under a fold of skin; a groove from eye back and down behind angle of jaw; gular fold to sides of neck; limbs short; toes very broad and flat, completely enveloped in web; tail a little longer than body, constricted at base, terete; anal lips smooth; vomerine series a patch of teeth in several irregular rows, not connected with parasphenoids, beginning behind outer edge of choanae, running straight in and back, separated from its fellow by the width of the nares, from the parasphenoids by the same distance; latter in a single patch beginning at anterior quarter of eyesocket; teeth on maxilla to middle of eyesocket; dark chocolate brown, slightly lighter in mid-region of belly; from eye to above groin a light grayish band fading out on tail; upper borders of this band quite indistinct due to a mid-dorsal darkening beginning on head and continuing on to tail; upper half of tail irregularly mottled with grayish; total length 145, head 16, body 64, tail 65.

Variations: A second female, M. C. Z. No. 2773, same data, varies in having the mid-dorsal darkening scarcely evident; total length 129, head 15, body 55, tail 59.

A young specimen, M. C. Z. 2431, same locality, has 4 folds between the appressed toes, the width of the head enters the length from tip of snout to vent 5½ times; the length of the head enters the length of the body 3 times; teeth on maxilla to level of nares; color somewhat lighter on the belly and the light dorsolateral band is less distinct than in the adults; tail shorter than body; total length 62, head 9, body 29, tail 24.

Boulenger's specimen, a male, measured 107, head 10, body 46, tail 51. Peter's specimen measured 125, head 12, snout to anus 66, tail 52. Both Peters and Boulenger mention tiny light linear markings on the ventral surface. This is not evident in the specimens before me.

Habits: Barbour and Cole (1906) say, "One specimen from Chichen

Itza, taken together with a single egg, in the damp earth near a watering trough on March 7." This specimen is now M. C. Z. 2431 and is not an adult. M. C. Z. No. 2773, two large adults, were dredged from the Sacred Cenote at Chichen Itza.

Remarks: This species is allied only to *lignicolor*. Brocchi's undescribed *"Spelerpes"* mentioned in the last paragraph of his description of *S. mulleri* seems to be this species. So also Werner's *S. doffleini* is unquestionably *yucatanus*.

Specimens seen 3, as follows:

Mexico: Chichen Itza, Yucatan 3 (M. C. Z. No. 2773, 2431).

It has been recorded from the Rio de la Passion, Guatemala (Brocchi 1883).

77. Yucatan, showing localities for Oedipus yucatanus.

OEDIPUS STRIATULUS NOBLE

1918 *Oedipus striatulus* Noble, Bull. Amer. Mus. Nat. Hist. 38, pl. 19, p. 344; 1921, Bull. Amer. Mus. Nat. Hist. 44, p. 2.

Type: Am. Mus. No. 6999; Mannhardt and Halter collectors.

Type locality: Cukra, near Bluefields, Nicaragua.

Range: Nicaragua and Costa Rica. Low country.

Diagnosis: An *Oedipus* with toes completely webbed, yellow ground color and dark stripes on back and on belly.

Description: U. S. N. M. 3771, adult male; Turrialba, Costa Rica; costal grooves 13; 4 costal folds between appressed toes; head width 6 in length from snout to vent; head length 3½ in length of body; head almost a semicircle in outline from above; eye as long as its distance from tip of snout; snout swollen; a swelling of upper lip below nostril but no developed cirrus; outline of upper jaw straight as seen from side; angle of jaw well back of hind angle of eye; hind part of both eyelids fitting under a fold of skin; a groove from eye back and down to behind angle of mouth; gular fold on sides of neck; limbs well developed; toes very broad and flat, completely enclosed in web; tail a little longer than head and body, cylindrical throughout; anal lips lined with papillae; vomerine tooth row not connected with parasphenoids, in a slightly curved series of 9-10 teeth, beginning behind outside edge of nares, passing nearly straight in and then curving a little back, separated by half width of nares, and from parasphenoids by ⅔ their own length; latter in a single patch beginning opposite hind border of eyesocket; teeth on premaxilla (2) not in line with those on maxilla, but forward, enlarged, and piercing lip separately; teeth on maxilla to level of nares; yellow, a black line from nostril through eye above insertions of legs to tip of tail; above this on each side a black line from nape to above groin, dividing dorsal surface into three light bands which are somewhat dotted with black; upper and under surface of tail dotted with black; a black streak on mid-line of nape; black dots on head; belly with median black streak from gular fold to vent; other more irregular streaks on each side of belly; throat streaked with black; upper surfaces of limbs streaked with black; under surfaces of limbs mottled with black; total length 108, head 12, body 41, tail 55.

Variation: A female, A. M. N. H. No. 6998, Chontales, Nicaragua; differs in having head width 6½ in length from snout to vent; head

length 4 in length of body, snout less swollen; anal lips smooth, no premaxillary fangs; maxillary teeth to anterior edge of eyesockets; total length 125, head 12.5, body 49.5, tail 63.

A small example, M. C. Z. 7218, Surubres, Costa Rica, differs in the color being more cream color and reddish than black and yellow; lines on the dorsal region not so distinct, head width 5½ in length from snout to vent, tail shorter than head and body; total length 70, head 8.5, body 30.5, tail 30.

78. Costa Rica and Nicaragua, showing localities for Oedipus striatulus.

A smaller specimen in the Museo Nacional de Costa Rica, same locality, is 65, head 9.5, body 27.5, tail 29.

Habits: Noble (1918) says; "The type was found near Cukra under a fallen fence among dead, yellowish leaves which were strewn along a path leading to a deserted plantation. The brown and tan color pattern made the salamander very inconspicuous as it wiggled among

the leaves. In walking, this specimen raised the body from the ground, the tip of the tail barely touching the surface. When the specimen was put, while alive, in 30% alcohol, it immediately constricted off its tail at a point near the base. The specimen collected on Mt. Mombacho by Mr. Miller was found on the leaf of a tree about six feet above the ground."

Remarks: This is a very distinct species. No other *Oedipus* has the belly light with dark stripes. Its relationships are with *colonneus* of Panamá, and with *rufescens* of Mexico and Guatemala. It is thoroughly distinct from either.

Specimens seen 6, as follows:

Nicaragua: Cukra 1 (A. M. N. H. No. 6999, TYPE); Chontales Mts. 1 (A. M. N. H. No. 6998); Mt. Mombacho, 3,600 ft. 1 (A. M. N. H. No. 5426).

Costa Rica: Turrialba 1 (U. S. Nat. Mus. No. 37771); Surubres 2 (Mus. Comp. Zoöl. No. 7218).

OEDIPUS RUFESCENS COPE

1869 *Oedipus rufescens* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 104; 1879. Proc. Amer. Phil. Soc. 18, p. 267; Sumichrast 1881, Bull. Soc. Zoöl. France 6, p. 231; 1882, La Naturaleza 6, p. 78; Cope 1887, Bull. U. S. Nat. Mus. 32, p. 8; Dugés 1894, La Naturaleza (2), 2, p. 371; 1896, id., p. 482.

1877 *Geotriton rufescens* Smith, the Tailed Amphibians, p. 76.

1882 *Spelerpes rufescens* Boulenger, Cat. Batr. Grad. Brit. Mus. (2), p. 71; Günther 1902, Biol. Centr. Amer., p. 303.

1878 *Spelerpes adspersus* Mueller, Verh. Ges. Basel 6, p. 579.

1884 *Spelerpes lignicolor* Mueller, id. 7, p. 294.

Type: Apparently not now in existence. Collected by F. Sumichrast.

Type locality: Orizaba, Vera Cruz, Mexico.

Range: Southern Mexico, Guatemala.

Diagnosis: An *Oedipus* with completely webbed toes, belly dark, vomerine series of 9 teeth reaching middle of nares, no teeth on maxilla, light dorsal surface with darker streaks.

Description: M. C. Z. No. 36621, adult female; Cacas, Trece Aguas, Alta Vera Paz, Guatemala; costal grooves 13; 3 costal folds between appressed toes; head width 5 in length from tip of snout to vent; head length 3 in length of body; head a blunt oval; eye as long as its distance from tip of snout; snout somewhat swollen; a swelling of upper lip below nostril; outline of upper jaw sinuous as seen from side; angle of jaw slightly back of hind angle of eye; both eyelids

fitting under a fold of skin behind; a groove from eye back and down behind angle of jaw; gular fold to sides of neck; limbs well developed; toes and fingers enclosed in webs; tip of third toe and third finger projecting slightly; tail constricted off at base, terete, about as long as body; anal lips smooth; vomerine teeth not connected with parasphenoids, about 9 teeth in series, beginning behind middle of nares, extending in and back in a nearly straight line, separated from each other by width of nares, and from parasphenoids by same distance, latter in a single patch beginning about first third of eyesockets; no teeth on maxilla; light gray above, a dark line from nostril through

79. Mexico and Guatemala, showing localities for Oedipus rufescens.

eye above insertions of legs fading out on tail; belly lighter than sides, but with no definite lower border to the dark lateral stripe; limbs above mottled with dark, below lighter; total length 67, head 10, body 29, tail 28.

Variations: No adult males have been seen. Young males and other females agree in general with the above description, save that rather frequently the color is reddish rather than grayish and in both red and gray specimens there is a triangular mark between the eyes, with the apex directed backwards, and an X-shaped mark between the insertions of the arms which receives the apex of the nape triangle; the anterior arms of this X are much darker than the other

dorsal markings and are no longer than the eye, the hind arms of the X are rather faint, and extend, equidistant from each other and from the dark lateral band, to above the groin. Four costal folds may separate the appressed toes. The nostril is actually larger in the tiniest specimens than in the largest. The tail varies from a little longer than the body to a good deal shorter.

Largest specimen seen (female)	73	10.5	30	32.5
Smallest specimen seen (female)	22	4.5	9.5	8

Remarks: This is a very distinct species. Its relationships are not easy to fix, but are apparently with *lignicolor-yucatanus*, with *striatulus*, and with *colonneus*. As *yucatanus* occurs in nearly the same region with no approach it is probably more closely allied to the two latter, both of which are likewise small species with dorsal streaking. Like *rufescens*, *colonneus* has no maxillary teeth. The three are well distinct.

Habits: Sumichrast (1881) says that it is "alpine" on Orizaba, which is somewhat ambiguous, for otherwise it is a hot country form. He says further that it lives in tufts of Tillandsia, in the forests of the Pacific Coast at 800–1,000 meters on Cerro Prieto, north of Santa Efigenia, Oaxaca.

Specimens seen 20, as follows:

Mexico: Cordoba, Vera Cruz 2 (U. S. Nat. Mus. No. 38304-5); El Potrero, Vera Cruz 2 (U. S. Nat. Mus. No. 32413-4); Santa Efigenia, Oaxaca 2 (U. S. Nat. Mus. No. 10042); Tabasco 1 (U. S. Nat. Mus. No. 26168).

Guatemala: Trece Aguas, Alta Vera Paz 11 (U. S. Nat. Mus. No. 36620-7, 37844, 38318-9); near Panzos, Alta Vera Paz 1 (U. S. Nat. Mus. No. 37845).

No locality: U. Mich. No. 43972.

It has been recorded also from the following Mexican localities: Orizaba, Vera Cruz (Cope 1869); Tehuantepec, Oaxaca (Cope 1879); Ixtacomitan, Mineral de Santa Fe, Chiapas (Dugés 1896).

OEDIPUS COLONNEUS DUNN

1924 *Oedipus colonneus* Dunn, Zoöl. Ser. Field Mus. 12, p. 96.

Type: M. C. Z. No. 9406, collected by E. R. Dunn and Chester Duryea.

Type locality: La Loma, on trail from Chiriquicito to Boquete, Atlantic side, altitude about 2,000 feet, Bocas del Toro, Panama.

Range: Known only from type locality, and possibly from same trail at 5,800 feet on the Pacific side.

Diagnosis: An *Oedipus* with fully webbed toes; no teeth on maxilla; vomerine teeth 9, beginning behind inner edge of nares; belly light gray; dorsal surface reddish gray much obscured by darker streaking; a dermal ridge across head and eyelids.

Description: M. C. Z. No. 9406, adult female; 13 costal grooves; 4 costal grooves between appressed toes; head width 6 in length from snout to vent; head length 3⅓ in length of body; head truncate, nostrils at angles; eye less than its distance from tip of snout; snout swollen; a tubercle below nostril; outline of upper jaw convex as seen from side; angle of jaw back of hind angle of eye; upper eyelid fits over lower behind; a dermal ridge across head between eyes, extending onto eyelid; an additional tubercle on eyelid posterior to this; grooves of head obsolete; limbs well developed; fingers and toes palmate; third finger and third toe longest, their lips projecting slightly beyond web; tail constricted at base; anal lips smooth; tail longer than body; vomerine teeth 9 in series, beginning behind inner edge of nares, extending in and back, separated from its fellow by width of nares and from parasphenoids by twice that distance; parasphenoids in a single patch beginning opposite middle of eyesocket; no teeth on maxilla; reddish gray above; light gray below; on dorsal surface and sides the ground color is obscured by brownish black streaking, and shows clearly only on top of the head; total length 82, head 10, body 32, tail 40.

Habits: This specimen was caught at night as it sat on a leaf about a foot from the ground near a small brook. It was sluggish.

Remarks: The dermal ridge across the head is unique in the genus. Unfortunately only a single specimen was secured so that possibly it is abnormal, although it has every appearance of normality. The relationships are not very evident. The other palmate species without maxillary teeth is *rufescens*, and it may be allied to that form or to *striatulus*, another small species with dorsal streaking. The specimen, although a female, shows a strongly swollen snout.

This is perhaps as good a place as any to mention a tiny salamander taken by Mrs. Gaige at 5,800 feet along the Boquete-Chiriquicito trail on the Pacific side of the divide.

This specimen was "in the middle of a log that was so hard we had to chop it open."

The head width is 4½ in the length from snout to vent; head length

3 in length of body; costal grooves 13; 4 costal folds between appressed toes; yellowish gray with reddish gray markings; head and throat darkest; lightest on the dorsum of tail; no demarcation between back and sides; a dark spot on scapular region; on hip region a median and two lateral darker stripes; a groove from eye to gular fold; total length 43, head 6, body 18, tail 19.

This specimen is very like young *rufescens*. In view of the close relationship between *rufescens* and *colonneus;* in view of the lack of knowledge as to the variability or the young of *colonneus;* in view of

80. Panamá, showing localities for Oedipus colonneus.

the geographical probabilities which are strongly in favor of *colonneus* and as strongly opposed to *rufescens,* it is perhaps the best plan to mention the specimen here with a query.

Specimens seen 2, as follows:

Panamá: Chiriqui: Trail from Chiriquicito to Boquete, Pacific side, 5,800 ft. 1 (?) (U. Mich.).

Bocas del Toro: Trail from Chiriquicito to Boquete, Atlantic side, La Loma, 2,000 ft. 1 (M. C. Z. No. 9406, TYPE).

OEDIPUS LINEOLUS (COPE)

1865 *Spelerpes lineolus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 197; 1866, id., p. 132; 1868, id., p. 313; Boulenger 1882, Cat. Batr. Grad. Brit. Mus. (2), p. 74.

1869 *Opheobatrachus lineolus* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 102.

1884 *Geotriton lineolus* Garman, Bull. Essex Inst. 16, p. 39.
1887 *Oedipina lineolus* Cope, Bull. U. S. Nat. Mus. 32, p. 8.
1896 *Oedipina lineola* Cope, Amer. Nat., p. 1022.
1924 *Oedipus lineolus* Dunn, Zoöl. Ser. Field Mus. 12, p. 99.
1879 *Spelerpes (Oedipus) infuscatus(?)* Peters, Mon. Berl. Ac., p. 778 (Haiti).
1902 *Spelerpes uniformis* Günther (? part), Biol. Centr. Amer., p. 304.

Type: Acad. Nat. Sci. No. 735. Collected by Dr. Charles Sartorius.

Type locality: Mexican Table-land.

Range: Southern Mexico.

Diagnosis: A worm-like *Oedipus* with blunt snout and 14 costal grooves.

Description: U. S. Nat. Mus. No. 30353, male; Mexico; 14 costal grooves; 8 costal folds between appressed toes; head width 8 in length from snout to vent; head length 4⅖ in length of body; head a broad oval from above; eye longer than its distance from tip of snout; edge of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs weak; fingers 3, 2, 4, 1 in order of length, tips of all but 1 free; toes 3, 2, 4, 5, 1 in order of length, tips of all but 1 free; tail imperfect, not constricted at base, terete, longer than head and body; anal lips lined with papillae; vomerine teeth 10 in series, beginning behind outer edge of nares, curving in and back, separated by ½ width of nares, and from parasphenoids by twice width of nares; latter in two incompletely separated patches beginning opposite middle of eyesocket; uniform black above and below; total length 62, head 5, body 22, tail 35.

Variation: Mus. Comp. Zoöl. No. 8381, female; Jalapa, Vera Cruz, Mexico; has 10 costal grooves between the appressed toes; head length 5 1/7 in length of body; no anal papillae; vomerine teeth 11 in series, separated from its fellow by width of nares; black above and below, legs, lips, and throat whitish; total length 128, head 7, body 36, tail 85.

Remarks: Related to the Panamanian *complex* which has 17 costal grooves, and to *uniformis* which has 19 and ranges from Panamá to Honduras. Probably this is the species which Günther (1902) records as *S. uniformis* "Vera Cruz" (Dugés). I have not been able to find any published reference by Dugés to *uniformis*.

I regard the Haitian *infuscatus* as identical with *lineolus* and its provenance as erroneous. The type, Berlin Museum No. 6556, has been examined by Noble, who tells me it is a very young individual. The description is that of an animal whose proportions are those of *lineolus*. "The tip of the tail is reproduced" could be said of no *Oedipus* save one of the "Oedipinas." "The hind limb reaches to the antepenultimate groove" indicates that the leg was shorter than that of *parvipes*, which Peters described on the same page, and whose leg

81. Mexico, showing localities for Oedipus lineolus.

reached over four folds. Thus from two points in the original description the animal was one of the worm-like forms, and the head width, "7 times in the distance from snout to anus," indicates only less clearly the same conclusion. The measurements given are, "total length 43 mm., head 4.5 mm., snout to anus 21." The Berlin Museum received the animal from the Museum Godeffroy. No other salamander has ever been found in the West Indies, and inasmuch as the description of this one is practically the same as a description of *lineolus*, it seems safe to drop the Haitian salamander from the list.

Specimens seen 3, as follows:

Mexico: Mexican Table-land 1 (A. N. S. 735, type); Jalapa, Vera Cruz 1 (M. C. Z. 8381); no locality 1 (U. S. N. M. 30353).

Cope (1866) records it from Orizaba, and (1868) from Cordoba, both in Vera Cruz.

OEDIPUS COMPLEX DUNN

1924 *Oedipus complex* Dunn, Occ. Papers Boston Soc. Nat. Hist. 5, p. 94.

Type: M. C. Z. No. 9408, young male.

Type locality: Las Cascadas, near Gamboa, Canal Zone.

Range: Known only from type locality.

Diagnosis: A worm-like *Oedipus* with reduced limbs; toes fully webbed; 17 costal grooves; maxillary teeth present; snout short and blunt; eye as long as its distance from tip of snout.

Description: M. C. Z. No. 9408, young ♂; 17 costal grooves; 9 costal folds between appressed toes; head width 7½ in length from snout to vent; head length 5⅖ in length of body; head a blunt oval as seen from above; eye longer than its distance from tip of snout; angle of jaw back of upper angle of eye; outline of upper jaw convex as seen from side; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; tail longer than head and body, constricted at base, terete; lips of vent papillate; limbs weak; fingers 3, 2, 4, 1 in order of length, completely webbed, tip of 3 projecting slightly; toes 3, 4, 2, 5, 1 in order of length, completely webbed, tip of 3 projecting slightly; vomerine teeth 8-9 in series, beginning beyond outer border of nares, curving in and back, separated from its fellow by width of nares and from parasphenoids by twice that distance; latter in a single patch, beginning opposite anterior fourth of eyesocket; maxillary completely toothed; brownish black, with brown flecks above; these are most concentrated on the dorsum of the tail and in a dorsolateral line on each side of the body; leaden below with light flecks; total length 67 mm., head 5, body 27, tail 35.

Variation: Five additional specimens in the Mus. Comp. Zoöl., from Fort Sherman, Canal Zone, show that the basal constriction of the tail is very weakly developed, as two have the tail incomplete and broken off some distance from the base.

The largest have flecks of light cream-color on the back and limbs. The two smallest have a light dorsal band. All five are dark below.

Measurements of the series:

Sex	*Total*	*Head*	*Body*	*Tail*	
♀	115	7	37	71	
♀	88	6	35	47	(tail incomplete)
♂	87	7	33	47	
yg	62	6	26	30	(tail incomplete)
yg	43	4	20	19	

82. Panamá, showing locality for Oedipus complex.

Habits: The type was taken while a termite's nest was being cut from a log.

Remarks: Probably most nearly allied to *O. uniformis* from which it differs mainly in having 17 rather than 19 costal grooves. From the other form with 17 costal grooves, *parvipes,* it differs widely in

shape of head, size of eye, maxillary dentition, and to a less extent in the amount of webbing of the toes.

Specimens seen 6, as follows:

Panamá: Canal Zone: Las Cascadas, near Gamboa 1 (M. C. Z. No. 9408, TYPE); Fort Sherman 5 (M. C. Z.).

OEDIPUS UNIFORMIS (KEFERSTEIN)

1868 (Aug. 12) *Oedipina uniformis* Keferstein, Nach. Ges. Göttingen 15, p. 331; 1868, Arch. f. Naturg. (1), p. 2, pl. 9, f. 8-9; Dunn 1918, Bull. Mus. Comp. Zoöl. 62, p. 471; Noble 1921, Proc. Amer. Mus. Nat. Hist. 44, p. 2 (skull).

1870 *Spelerpes uniformis* Strauch, Mém. Acad. Sci. St. Petersbourg (7), 16, 4, p. 84; Boulenger, Cat. Batr. Grad. Brit. Mus. (2), p. 75; Günther 1902, Biol. Centr. Amer., p. 304.

1924 *Oedipus uniformis* Dunn, Zoöl. Ser. Field Mus. Nat. Hist. 12, p. 99.

1868 (Oct.) *Ophiobatrachus vermicularis* Gray, Ann. Mag. Nat. Hist. (4), 2, p. 298 (Costa Rica, type in British Museum).

1869 *Opheobatrachus vermicularis* Cope, Proc. Acad. Nat. Sci. Philadelphia, p. 102; 1875, Journ. Acad. Nat. Sci. Philadelphia (2), 8, p. 96.

1877 *Spelerpes vermicularis* Smith, the Tailed Amphibians, p. 94; Brocchi 1883, Miss. Sci. Mex., p. 118, pl. 20, f. 1.

1893 *Haptoglossa pressicauda* (?) Cope, Proc. Amer. Phil. Soc. 31, p. 334 (Palma, Costa Rica, type destroyed).

Type: In collection of Göttingen University(?). Collected by Seebach.

Type locality: Costa Rica.

Range: Western Panamá to Honduras. Guatemala(?).

Diagnosis: A worm-like *Oedipus* with 19 costal grooves; teeth on maxilla; black above and below and head bluntly rounded in front.

Description: M. C. Z. No. 6940, adult male; Zent, Costa Rica; 19 costal grooves; 12 costal folds between appressed toes; head width 8½ in distance from snout to vent; head length 5⅔ in length of body; eye as long as its distance from tip of snout; head a blunt oval from above; snout swollen, especially below nostril; outline of upper jaw straight as seen from side; angle of jaw below hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold, a groove from this down behind angle of jaw; limbs weak; fingers 3, 2, 4, 1 in order of length, united to tip; toes 3, 4, 2, 5, 1 in order of length, united to tip; tail nearly twice as long as head and body, not constricted at base, circular in cross section; anal lips with a few papillae; vomerine teeth about 13 in series, beginning beyond

outer border of nares, curving in and back, separated from its fellow series by the width of the very small nares, and from the parasphenoids by twice that distance; latter in a single patch beginning opposite anterior fourth of eyesocket; premaxillary teeth not enlarged nor piercing lip, consisting of three teeth, separated by a slight gap from, and

83. Panamá to Honduras, showing localities for Oedipus uniformis.

in line with, the exactly similar maxillary teeth; deep black, slightly lighter below; a circular white dot just back of insertion of hind leg; legs somewhat brownish, lips of anus white; total length 150, head 7.5, body 43, tail 99.5.

Variation: A female, M. C. Z. No. 6939, same locality, differs as

follows: head width 8¾ in length from snout to vent; head length about 6 in length of body; tail imperfect; anal lips smooth; total length 107.5, head 6.5, body 38, tail 63.

A young specimen, M. C. Z. 6949, same locality; head width 5¾ in length from snout to vent; head length about 5 in length of body; nostrils twice as large in actual diameter as those of adults; tail shorter than body; total length 31, head 3.5, body 17, tail 10.5.

The head width ratio varies from 5¾-12, in adults from 8½-12. Doubtless much of this depends on the state of preservation. The head length ratio varies from 4¾-7.

Largest	♂	M. C. Z. 6040	150	7.5	43	99.5	Zent, C. R.
Largest	♀	U. S. N. M. No. 37769	216	8	53	155	La Palma, C. R.
Smallest spec.		M. C. Z. No. 6949	31	3.5	17	10.5	Zent, C. R.

Habits: This species burrows in very old and rotten logs. In such places 17 out of 18 were taken in the summer of 1920. The exception, M. C. Z. No. 6949, the only young specimen seen, was walking on the floor of the forest during a rain. They are quite active and not easy to catch, in marked contrast to the less elongate species of the genus, which are very inert and sluggish.

Remarks: Most closely allied to *O. complex* of the Canal Zone, which has 17 costal grooves instead of 19. Less closely allied to *lineolus* of Mexico which has 14 costal grooves.

The records from Guatemala are not wholly satisfactory. Cope (1869) records it from there, although he does not mention having seen any specimens and although neither Gray nor Keferstein, both of whom wrote in the latter half of 1868, mention any locality save Costa Rica. Brocchi (1883) also says Guatemala and figures a specimen said to be from there. Günther (1902) records it from Vera Cruz, but probably this record refers to *lineolus*.

Cope's *Haptoglossa pressicauda* is probably the present form. The type has been destroyed. The proportions, dentition, color, and indeed everything except "the tongue adherent in front and by the middle" are so like those of young *uniformis* that I cannot help thinking they are the same. I include it in the synonymy with a query.

Specimens seen 36, as follows:

Panamá: La Loma, 2,000 ft., on trail from Chiriquicito to Boquete 1 (M. C Z. No. 9831).

Costa Rica: Suretka 4 (M. C. Z. No. 9827-30); Zent 10 (M. C. Z. No. 6939-43, 6945-9); Monteverde 2 (M. C. Z. No. 6930-1); Guapiles 6 (M. C. Z. No.

6932-7); Turrialba 1 (U. S. N. M. No. 37770); Cartago 1 (M. C. Z. No. 2821); La Palma 3 (U. S. N. M. No. 37767-9); San Jose 1 (U. S. N. M. No. 32654); Alajuela 2 (A. M. N. H. No. 7449-50); no locality 4 (U. S. N. M. No. 30605-6, 67109-10).

Honduras: Dept. of Mosquitia: Claura River, 6 miles inland, alt. 20 ft. 1 (U. Mich. No. 58610).

It has also been recorded from Irazu and Bebedero, Costa Rica (Günther 1902); Palma, Costa Rica, near the Golfo Dulce (Cope 1893); Guatemala (Cope 1869).

OEDIPUS COLLARIS (STEJNEGER)

1907 *Spelerpes collaris* Stejneger, Proc. U. S. Nat. Mus. 32, p. 465.
1924 *Oedipus collaris* Dunn, Zoöl. Ser. Field Mus. Nat. Hist. 12, p. 99.

Type: U. S. Nat. Mus. No. 37350. Collected by W. F. Thornton.

Type locality: Topaz mine, 90 miles northwest of Bluefields, Nicaragua, and 50 miles back in direct line from the coast, elevation 400 feet.

Range: Nicaragua to western Panama.

Diagnosis: A worm-like *Oedipus* with 19 costal grooves; snout sharp; teeth on maxilla; black, lighter dorsal markings.

Description: U. S. N. M. No. 37350, adult male; Nicaragua; costal grooves 19; eleven costal folds between appressed toes; head width 7½ in length from tip of snout to vent; head length 3½ in length of body; head a blunted oval; eye less than its distance from nostril; snout swollen, no canthus rostralis; a swelling of upper lip below nostril but no developed cirrus; outline of upper jaw straight as viewed from side; angle of jaw just back of hind angle of eye; upper eyelid fits over lower; a groove from eye back to gular fold, which meets a groove extending backwards from angle of jaw; limbs weak; fingers short, scarcely flattened, more united than webbed 3, 2, 4, 1 in order of length, the last joint of 3 and 2 free of membrane; toes similar to fingers, 4, 3, 2, 5, 1 in order of length and with last joint of 4 and 3 free of membrane; tail missing; anus with lips lined with papillae; vomerine teeth about 9 in series, not connected with parasphenoids, beginning beyond nares and extending straight across mouth towards its fellow, from which it is separated by one-third its length; parasphenoids in two patches incompletely divided anteriorly and distant from vomerines by one-half the length of the latter; two enlarged teeth on premaxilla emerge outside edge of lip; "color (in alcohol)

uniform plumbeous, the body color being a mixture of minute black specks dusted over a pale ground; edge of gular fold and a semilunar mark around the insertion of the legs, as well as a spot in the bend of the elbow and of the knee, pale; the side of the head shows indications of being pale with a large dark preocular spot and a narrow black postocular streak;" total length 73, head 13, body 59, tail 1 (missing).

84. Panamá to Nicaragua, showing localities for Oedipus collaris.

Variation: A male, M. C. Z. 9831, La Loma, on trail from Chiriquicito to Boquete, Bocas del Toro, Panama, altitude about 2,000 feet; differs as follows: head length 5 in length of body; head width 8⅔ in length from snout to vent; 10 costal folds between appressed toes; vomerine teeth 11-12 in series, separated by twice width of nares and from parasphenoids by the width of nares; the color differs somewhat from Stejneger's description of the type; it is from life; black above and below; a gray band on each side between insertions of legs; this band has a definite lower edge and an indefinite upper edge;

snout lighter, tinged with brown; tail with many white flecks on sides; total length 218, head 10, body 50, tail 158.

Habits: The specimen from La Loma was under a fallen palm leaf near the bank of a small brook. Its extremely elongate form gave the impression of a snake, which was not dispelled when I attempted to seize it and it dashed into the water. Not until I had it in my hand did I realize that I was dealing with a salamander. Such actions are very different from the sluggishness typical of most *Oedipus*, although other elongate forms *(parvipes, alfaroi, uniformis)* which I have seen are quite active also.

Remarks: It has no near relatives. Remotely allied to *parvipes, collaris* is like it, a link between the mass of the genus, and the forms which have been considered *Oedipina*. The distinction is broken down and I can no longer regard the latter genus as tenable.

Specimens seen 2, as follows:

Nicaragua: Inland from Bluefields 1 (U. S. N. M. 37350).
Panama: La Loma 1 (M. C. Z. 9831).

OEDIPUS PARVIPES (PETERS)

1879 *Spelerpes (Oedipus) parvipes* Peters, Mon. Berlin Ac., p. 778.
1882 *Spelerpes parvipes* Boulenger, Cat. Bat. Grad. Brit. Mus. (2), p. 74; 1914, Proc. Zoöl. Soc. London, p. 813.
1924 *Oedipus parvipes* Dunn, Zool. Ser. Field Mus. 12, p. 99.

Type: Probably in the Berlin Museum. Collected by Th. Grosskopf.

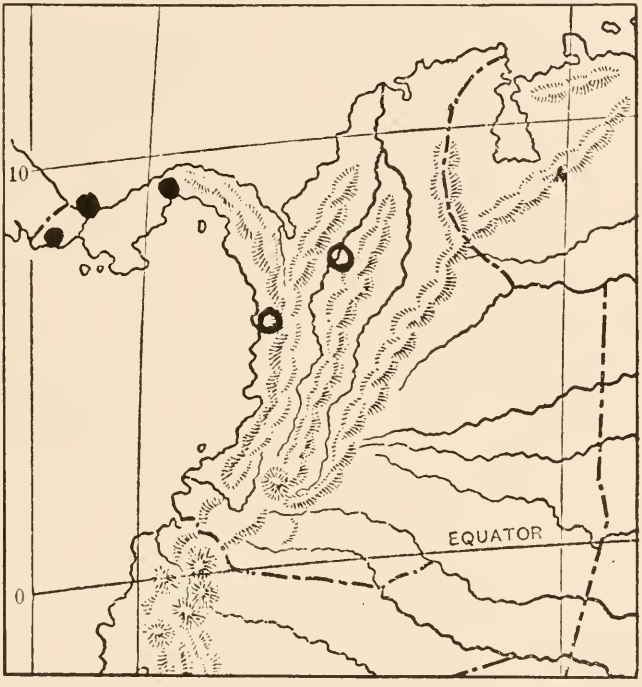
Type locality: Laceres [Caceres(?)] on the Cauca river, province of Antioquia, Colombia.

Range: Northwestern Colombia to western Panama.

Diagnosis: An *Oedipus* with elongate, worm-like habitus, sharp snout, 17 costal grooves.

Description: M. C. Z. No. 9836, adult male; La Loma, on trial from Chiriquicito to Boquete, 2,000 ft. alt.; 17 costal grooves; 8 costal folds between appressed toes; each limb reaching over four folds; head width 9 in length from snout to vent; head length 5 in length of body; head a truncate oval, nostrils in from corners; eye as long as its distance from nostril; snout swollen; angle of jaw back of hind angle of eye; outline of upper jaw concave; both eyelids fitting under a fold of skin behind; a groove from eye back and down behind angle of jaw;

tail nearly twice as long as head and body, constricted off at base, cylindrical and tapering to a point; anal lips lined with papillae; limbs weak; fingers 3, 2, 4, 1 in order of length, tips of 2 and 3 free; toes 3, 4, 2, 1, 5 in order of length, tips of 3, 4 and 2 free; vomerine teeth 6 in series, beginning beneath outer border of nares, curving in and back, separated from its fellow by ½ width of nares, and from para-



85. Colombia and Panamá, showing localities for Oedipus parvipes.

sphenoids by three times that distance; parasphenoids in a single patch beginning opposite middle of eyesockets; teeth on maxilla only to nares; two enlarged teeth on premaxilla piercing lip; dull brown above; light gray below; lightest on throat; many light dots on sides; total length 122, head 7, body 35, tail 80.

Variation: M. C. Z. No. 9833, adult female, same data, differs in having the head width 9½ in length from snout to vent; 8 vomerine

teeth in series, separated from its fellow by width of nares; snout less swollen; vent not papillate; no premaxillary fangs; total length 114, head 7, body 37, tail 70. M. C. Z. No. 9835, a male, same data, has the tail broken some distance from base, and regenerating. U. Mich. No. 58499, male, from 100 feet altitude on the bank of the Chiriqui Viejo river, Province of Chiriqui, Panamá, has a groove from eye to gular fold; the top of the head is light, as is the dorsum of the tail; there is a dark streak on the sides; head width 8½ in length from snout to vent.

Peter's type from Laceres had the head width 11 in length from snout to vent; "black, upper side of head mainly white, gular fold white, sides of belly and tail sprinkled with white; on the upper arm, on the elbow, and on the base of the thigh, a white spot."

Measurements of specimens:

	Sex	*Total Length*	*Head*	*Body*	*Tail*	*Locality*
TYPE		100	7	37	56	Laceres
M. C. Z. No. 9833	♀	114	7	37	70	La Loma
M. C. Z. No. 9836	♂	122	7	35	80	do
M. C. Z. No. 9834	♂	105	7	36	62	do
M. C. Z. No. 9835	♂	66	6.5	33	26.5 (regen.)	do
M. C. Z. No. 9599	♀	113	8	41	64	Rio Chenillo
M. C. Z. No. 9600	♂	108.5	6.5	37	65	Ft. Randolph
M. C. Z. No. 9605	♂	140	7	42	91	Ft. Sherman
M. C. Z. No.	♀	120	7	38	75	do
M. C. Z. No. 9606	yg.	55	4.5	21.5	29	do
U. Mich. No. 58499	♂	118	7	36	75	Chiriqui Viejo R.

Habits: The La Loma specimens were taken near the ground, one in a ground bromeliad, one in moss on an old log, and two in rotten logs. The Chiriqui specimen was in a "rotted log, Chiriqui Viejo bank." The Ft. Randolph specimen was from "ditch in deep mud." The Rio Chenillo one was from a rotten log. The La Loma specimens were quite active.

Remarks: The specimens seen all pertain to a single form. The differences between this and the original description seem unimportant. Especially the difference in head width may be due to different preservation. This animal breaks down the distinction between *Oedipus* and *Oedipina*. It is related to the more degenerate *alfaroi* of Costa Rica. The small eye, long snout, and brown color are the same in both. But *alfaroi* has 20 costal grooves, as against 17 in *parvipes*, and there are no teeth on the maxilla.

Specimens seen 23, as follows:

Panamá: Bocas del Toro Province: La Loma, 2,000 ft. 4 (M. C. Z. No. 9833-6); Chiriqui Province: Rio Chiriqui Viejo, 100 ft. 1 (U. Mich. No. 58499); Canal Zone: Rio Chenillo 1 (M. C. Z. No. 9599); Fort Sherman 16 (M. C. Z. No. 9601-7); Fort Randolph 1 (M. C. Z. No. 9600).

It has also been recorded from Laceres [Caceres(?)], Colombia (Peters 1879), and from the Choco region of Colombia (Boulenger 1914), probably near Condoto.

OEDIPUS ALFAROI (DUNN)

1921 *Oedipina alfaroi* Dunn, Proc. Biol. Soc. Washington 34, p. 145.
1924 *Oedipus alfaroi* Dunn, Field Mus. Zoöl. Ser. 12, p. 99.

Type: Mus. Comp. Zoöl. No. 6938, adult female. Collected by E. R. Dunn.

Type locality: Zent, Costa Rica, altitude 100 feet.

Range: Known only from type locality and from near Suretka, in the Talamanca Valley, Costa Rica.

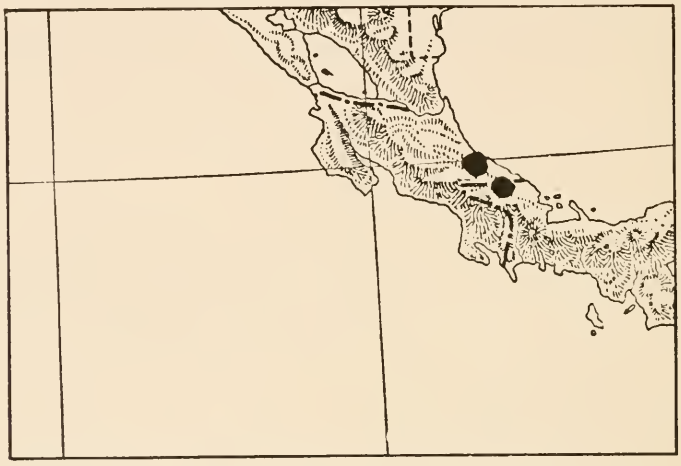
Diagnosis: A worm-like *Oedipus* with pointed snout, 20 costal grooves, no teeth on maxilla, brownish above, grayish below.

Description: M. C. Z. 6938, adult female; Zent, Costa Rica; 20 costal grooves; 14 costal folds between appressed toes; head width 12 in length from snout to vent; head length 7 in length of body; eye shorter than its distance from the nostril; head a pointed oval from above; snout not swollen; outline of upper jaw straight as seen from side; angle of jaw back of hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down behind angle of jaw; limbs weak; fingers 3, 2, 4, 1 in order of length, united to tips; toes 3, 4, 2, 5, 1 in order of length, united to tip; tail imperfect, not constricted at base, circular in cross section; anal lips smooth; vomerine teeth about 9 in series, beginning behind outer edge of nares, curving in and back, separated from its fellow by width of the large nares, and from the parasphenoids by the same distance; latter in a single patch beginning opposite anterior fourth of eyesocket; no teeth on maxilla, one premaxillary tooth not piercing lip; teeth on lower jaw confined to front half, normal in form and number; color purplish brown above, light grayish below, a white spot behind insertion of leg; total length 104, head 7.5, body 53, tail 43.5.

Variation: Another female, M. C. Z. 6944, same data, has an uninjured tail which is much longer than head and body; head width 14

in length from snout to vent; head length 7 2/7 in length of body; the vomerines are separated from the parasphenoids by twice the width of the nares; there is one premaxillary tooth and none on the maxilla; the mandible is toothed to below the middle of the eye; total length 132, head 7, body 51, tail 74.

A third female, M. C. Z. 9826, from Suretka, in the Talamanca Valley, Costa Rica, has 16 costal folds between the appressed toes; no groove from hind angle of eye; head width 13 in length from snout to vent; head length 6 5/7 in length of body; total length 157, head 7, body 47, tail 103.



86. Costa Rica, showing localities for Oedipus alfaroi.

Habits: Similar to those of *O. uniformis*. They may be taken in the same log.

Remarks: I have compared the original descriptions of *uniformis* and of *vermicularis* and they unquestionably refer to the same animal, which can easily be told from *alfaroi* in the field. I caught a third specimen at Zent but it wriggled from my hand and I could not find it again. It is more closely related to *parvipes* than to *uniformis*. It differs from *parvipes* sufficiently in costal groove count to make it amply distinct.

Specimens seen 3, as follows:

Costa Rica: Zent 2 (M. C. Z. 6938, 6944); Suretka 1 (M. C. Z. 9826).

Explicit Salamandrae Plethodontidae

ADDENDA

Shortly after I returned the last proofs of the foregoing pages I had an opportunity of examining the salamanders in the collection of the British Museum of Natural History. As my time was short I devoted my attention to the species and specimens of the genus *Oedipus* which seemed questionable, and concerning which I had been in some doubt. The following remarks deal with 13 species, the 130 specimens of which form a considerable increment to the 575 which I had previously seen.

Aside from a surprising new form from Mexico, the notes to follow are chiefly in the nature of additional locality records, and of the correct allocation of specimens previously recorded in the literature, and concerning whose position I had been compelled to surmise.

OEDIPUS GADOVII SP. NOV.

1893 *Spelerpes bellii* Blatchley, Proc. U. S. Nat. Mus. 16, p. 38.
1905 *Spelerpes orizabensis* Gadow, Proc. Zoöl. Soc. London, p. 193.

Type: B. M. N. H. No. 1903.9.30.312, adult male, collected by H. Gadow.

Type locality: Xometla, at 8,500 feet altitude on Mt. Orizaba, Mexico.

Range: Known only from type locality.

Diagnosis: Closely related to *O. bellii*, differing from it in smaller size, longer legs, longer digits, slimmer tail, a ventro-lateral as well as a dorsal series of light spots, and throat spotted with light.

Description: Type; 13 costal grooves; appressed toes overlapping; head width 5⅔ in length from snout to vent; head length 3⅙ in length of body; eye as long as its distance from tip of snout; snout slightly swollen; head oval as seen from above; outline of upper jaw sinuous as seen from side, turned down at angle; angle of jaw posterior to hind angle of eye; both eyelids fitting under a fold of skin behind; a groove from eye to gular fold; a groove from this down back of angle of jaw; limbs well developed; fingers 3, 2, 4, 1 in order of length, scarcely flattened, swollen at tips, webbed at base; toes 3, 4, 2, 5, 1 in order of length, scarcely flattened, swollen at tips, webbed at base; tail longer than head and body, slim and terete, a slight constriction

at base; vent lined with papillae; vomerine teeth 17 in series, beginning beyond outer border of nares, curving in and back, separated from its fellow by twice width of nares and from parasphenoids by four times that distance; latter in two patches beginning at anterior third of eyesocket; 5 premaxillary teeth enlarged and piercing lip; purplish brown, not quite uniform; an irregular line of cream colored spots from axilla to groin; a similar line from eye to gular fold; light mottling on throat and limbs; total length 174, head 20, body 63, tail 91.

Variation: A female, B. M. N. H. No. 1903.9.30.311, has the appressed toes separated by one costal fold; head width 6⅘; head length 3⅝; snout not swollen; tail longer than body; no papillae in vent; much darker than described male; all spotting smaller and more discrete; total length 165, head 18, body 65, tail 82.

A young specimen, B. M. N. H. No. 1903.9.30.331, from Xometla, at 13,000 feet altitude on Orizaba, shows a double dorsal series of small yellow spots, one to a costal fold; there is a large blotch on each side of the neck just back of the upper end of the gular fold; there is irregular light flecking on throat, limbs, lower part of sides, and dorsal surface of tail; the nostril is slightly larger than that of the adult male; total length 49, head 8, body 18, tail 23.

Several medium sized individuals are intermediate in color between the darker adults and the lighter young, all, however, showing the double dorsal series of spots. Three specimens (U. S. Nat. Mus. No. 19263-5) from 12,000 feet altitude on Orizaba, are all large and show no light markings (Blatchley 1893).

Habits: According to Blatchley and to Gadow this species is very common on Orizaba from 8,000 to 14,000 feet. It is found under logs and débris in forest.

Remarks: This species is closely related to *bellii* and appears to replace it at high altitudes on Orizaba. At similar altitudes on Popocatepetl, neither it nor *bellii* seem to occur. It seems even more primitive than *bellii,* and may well be the least specialized form in the genus.

The history of this species is very peculiar. Blatchley collected it in numbers on Orizaba, but brought back only three melanistic specimens. He considered it to be *bellii,* and as the peculiar spotting did not show in his three specimens, I overlooked the different proportions,

and made the same mistake. Blatchley also collected specimens of another species in Orizaba. These he considered to be new, and called *orizabensis*. However, the types are not to be distinguished from the types of *leprosus*, and they in turn from the description of *cephalicus*.

Gadow also collected the present form in numbers in Orizaba, but being more conversant with *bellii* recognized its difference. He, however, was in error in considering the present form to be Blatchley's *orizabensis*.

As the situation is somewhat complicated a brief statement follows: *bellii* Blatchley = *orizabensis* Gadow = *gadovii* of this paper; *orizabensis* Blatchley = *leprosus* Gadow = *cephalicus* of this paper; *bellii* Gadow = *bellii* of this paper.

Specimens seen 8, as follows:

Mexico: Vera Cruz; Mt. Orizaba 12,000 ft. 3 (U. S. N. M. No. 19263-5); Mt. Orizaba, Xometla, 13,000 ft. 1 (B. M. N. H. No. 1903.9.30.331); Mt. Orizaba, Xometla, 8,500 ft. 4 (B. M. N. H. No. 1903.9.30.309-312 TYPE).

OEDIPUS BELLII

8 specimens seen from La Cumbre de los Arrastrados, Talpa, Mascota, Jalisco, Mexico (92.10.31.95-102).

OEDIPUS ROBUSTUS

1 specimen from La Palma, Costa Rica (95.7.13.40). This was figured by Günther as *bocourti*.

OEDIPUS PENNATULUS

22 specimens from the following localities:

Cerro de San Felipe, Oaxaca, Mexico 5 (1903.9.30.326-30); Xometla, 8,000-9,000 feet altitude, Orizaba, Vera Cruz, Mexico 10 (1903.9.30.316-25); Orizaba, Vera Cruz, Mexico 2 (72.4.11.23-4); no locality or number 5.

The Xometla specimens show that the male has a larger nostril than the female, and has also a blunt cirrus.

OEDIPUS CEPHALICUS

28 specimens from the following localities:

Xometla, Orizaba, Vera Cruz, Mexico 8 (1903.9.30.299-304, 307-8); Xometla, 13,000 feet altitude 2 (1903.9.30.305-6); Jalapa, Vera Cruz, Mexico 8 (1901.12. 19.126-7, 81.10, 32-5); Popocatepetl 3 (1901.12.19.128-30); Southern Mexico 2; Mexico 5 (Lataste coll. 1920.1.20.1759, 57.7.31.33-6).

OEDIPUS ROSTRATUS

6 specimens from "Guatemala" (83.5.24.29-32).

OEDIPUS SUBPALMATUS

1 specimen from La Palma, Costa Rica (96.10.8.85 TYPE).

OEDIPUS ADSPERSUS

28 specimens from the following localities:

Bogota, Colombia 12 (65.6.12.19-20 Peters don., 1919.3.6.38-47); Merida, Venezuela 1 (1904.6.30.18); Fu_uesos, Venezuela, 3,500 m. alt. 5 (1905.5.31.105-9); Culata, Venezuela, 3,000 m. alt. 10 (1905.5.31.95-104).

OEDIPUS ALTAMAZONICUS

5 specimens from the following localities:

Moyobamba, Peru 1 (74.8.4.103 TYPE of *peruvianus*); Rio Pacaya or Ucayali, 200 ft. alt., Peru 3 (1913.7.28-29-31); Rio San Esteban, Venezuela 1 (1920.1.20. 3726).

The type of *peruvianus* agrees well with the Rio Ucayali specimens and with the others I have seen from Cochobamba, Bolivia and other localities as mentioned in the foregoing pages. The Venezuela specimen is large (total length 91, head 12, body 35, tail 44), it is dark brown, mottled with lighter, with a very light snout and a light tip to the tail. The vomerine series are short and straight. The specimen is from the Lataste collection. If it is not *altamazonicus* it is certainly extremely close to it.

OEDIPUS PLATYDACTYLUS

I examined 6 specimens from localities south of Mexico (all there were) as follows:

British Honduras 1 (91.8.27.19); Guatemala 1 (75.6.9.131); Pacific Coast of Guatemala 1 (75.6.9.131); San Carlos, Costa Rica 1 (96.10.8.77); Medellin, Colombia 2 (97.11.12.21-2).

The British Honduras and Guatemala specimens are referred to in the preceding pages as having been figured by Günther. The Guatemalan specimens are the only *platydactylus* from that country, and they are very large and in proportions reminiscent of *attitlanensis*. The San Carlos specimen is the one mentioned by Günther and is cer-

tainly *platydactylus* rather than any other described form. It has a rather broken dorsal light band, but differs from the British Honduras specimen in that the fragmentation is irregular and not into three stripes. This fragmentation is still more apparent in the Medellin specimens, in which there is dorso-lateral white spotting decreasing in amount from eye back to groin on one side and to middle of body on the other side of one specimen and to the shoulder on both sides in the other specimen. These may represent an undescribed form, but as with the San Carlos specimen they are *platydactylus* rather than any other known species.

OEDIPUS STRIATULUS

1 specimen from San Ramon, Nicaragua, 375 ft. alt. (1908.5.29.121).

OEDIPUS UNIFORMIS

14 specimens from the following localities in Costa Rica:

La Palma 6 (96.10.8.78-83); Irazu 1 (94.12.28.24); San Jose 5 (1902.1.28.41-5); Bebedero 1 (94.11.15.34); no locality 1 (68.8.17.5 TYPE of *vermicularis*).

The Bebedero specimen seems lighter in color with dark flecks. A paper label attached to it reads "San Jose."

OEDIPUS PARVIPES

2 specimens from Pena Lisa, Condoto, Colombia (1914.5.21.90); and Paramba, 3,500 m. alt., N. W. Ecuador (1901.3.29.115). The latter has a large white patch on the top of the head from between the eyes to the neck. It is also darker in color than usual in *parvipes*.

I examined all of the species mentioned above in the collection except for *bellii* and the Mexican specimens of *platydactylus*. I did not have time to examine the specimens of *chiropterus, picadoi, salvinii, yucatanicus, lignicolor, rufescens,* or *lineolus,* although specimens of these forms were in the collection.

Various remarks in synonymies and in list of specimens seen and in records should be considered as corrected by these addenda.

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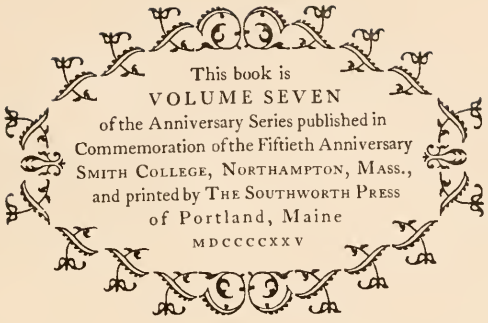
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